CIE Scheme

Assessment	Weightage in Marks
TEST 1	20
TEST 2	20
RECORD	10
Total	**50**

SEE Scheme

Semester End Examination (SEE) is a practical examination of three hours duration of 50 marks.

Sl. No.	Marks allotment		
1	Procedure and Conduction	ONE Question from Chapter 1, 2, 3	10Marks
		ONE Question from Chapter4	20Marks
		ONE Question from Chapter5,6	10Marks
2	Viva	_	10 Marks
Total Marks			50 Marks

Syllabus

Out Come Based Education

III & IV Semester
Bachelor Degree
in
Electronics and Communication Engineering

2013-14

P.E.S. College of Engineering

Mandya - 571 401. Karnataka

(An Autonomous Institution Affiliated to VTU Belgaum)

Grant -in- Aid Institution

(Government of Karnataka)

Accredited by NBA, New Delhi

Approved by AICTE, New Delhi.

Ph : 08232- 220043

Fax : 08232 - 222075

Web : www.pescemandya.org

P.E.S.COLLEGE OF ENGINEERING, MANDYA-571401 (KARNATAKA)
(An Autonomous Institution under V.T.U. Belgaum)

Vision

"An institution of high repute, imparting quality education to develop innovative and humane engineers"

Mission

"Committed to develop students potential through high quality teaching - learning processes and state of the art infrastructure"

Course Assessment Matrix (CAM)

Course Outcome (CO)		Program Outcome (ABET/NBA-(3a-k))										
		a	b	c	d	e	f	g	h	i	j	k
Write the 8086 – assembly language programs to perform data transfer and arithmetic operation.	L3	2	2	2	-	-	-	-	-	-	-	-
Write the 8086 – assembly language programs to demonstrate the operations of binary up and down as well as decimal up and down counters.	L3	2	2	2	-	-	-	-	-	-	-	-
Develop the programs to implement bit level logical operation.	L5	3	2	3	-	3	-	-	-	-	-	-
Demonstrate the use of conditional CALL and RETURN instructions.	L3	1	1	-	-	-	-	-	-	-	-	-
Write the programs to achieve code conversions.	L3	2	2	2	-	-	-	-	-	-	-	-
Develop the programs to use the DOS interrupts to accept character from keyboard and display.	L5	3	2	3	-	2	-	-	-	-	-	-
Write the 8051 – assembly language programs for implementing logical and arithmetic operations.	L3	2	2	2	-	-	-	-	-	-	-	-
Develop the programs to generate sine, square, triangular, ramp waveforms using DAC interface.	L5	3	3	2	-	2	-	-	-	-	-	-
Demonstrate the interfacing of Seven segment LED display, Keypad and stepper motor.	L3	2	1	-	-	-	-	-	-	-	-	-
1 – Low, 2 – Moderate and 3 – High												

Course Articulation Matrix (CAM)

Course Outcome (CO)		Program Outcome (ABET/NBA-(3a-k))										
		a	b	c	d	e	f	g	h	i	j	k
Write the 8086 – assembly language programs to perform data transfer and arithmetic operation.	L3	M	M	M	-	-	-	-	-	-	-	-
Write the 8086 – assembly language programs to demonstrate the operations of binary up and down as well as decimal up and down counters.	L3	M	M	M	-	-	-	-	-	-	-	-
Develop the programs to implement bit level logical operation.	L5	H	M	H	-	H	-	-	-	-	-	-
Demonstrate the use of conditional CALL and RETURN instructions.	L3	L	L	-	-	-	-	-	-	-	-	-
Write the programs to achieve code conversions.	L3	M	M	M	-	-	-	-	-	-	-	-
Develop the programs to use the DOS interrupts to accept character from keyboard and display.	L5	H	M	H	-	M	-	-	-	-	-	-
Write the 8051 – assembly language programs for implementing logical and arithmetic operations.	L3	M	M	M	-	-	-	-	-	-	-	-
Develop the programs to generate sine, square, triangular, ramp waveforms using DAC interface.	L5	H	H	M	-	M	-	-	-	-	-	-
Demonstrate the interfacing of Seven segment LED display, Keypad and stepper motor.	L3	M	L	-	-	-	-	-	-	-	-	-

L- Low, M- Moderate, H-High

DEPARTMENT OF ELECTRONICS AND COMMUNICATION ENGINEERING

About the Department

In the department, the B.E degree was started in 1972 and the M.Tech degree in 2006 , the Ph.D and M.Sc (by research) programmes in 2004 . Currently the strength of teaching faculty is 20 and that of non teaching staff is 14. The present intake of B.E course is 120 and that of M.Tech course is 49 . The teacher – student ratio is 1:16. The department has a research centre under VTU , with 4 research guides and 17 research students . During the last five years, the department has published 15 technical papers in international journals and 10 technical papers in national journals. So far, the department has organized one international and one national conferences

Vision

Developing high quality engineers with sound technical knowledge, skills and ethics in order to meet the global technological and societal demands in the area of Electronics and communication Engineering.

Mission

- Developing high quality graduates and post-graduates of Electronics and communication Engineering with modern technical knowledge, professional skills and attitudes in order to meet industry and society demands.
- Developing graduates with an ability to work productively in a team with professional ethics and social responsibility.
- Developing highly employable graduates and post graduates who can meet industrial requirements and bring innovations.
- Moulding the students with foundation knowledge and skills to enable them to take up post-graduate programmes and research programmes at the premier institutes.
- Providing students with an excellent academic ambience to instill leadership qualities, character moulding and life-long learning necessary for a successful professional carreer.

DEPARTMENT OF ELECTRONICS & COMMUNICATION ENGINEERING

A) Programme Educational Objectives(PEOs)

of Bachelor of Engineering Programme in Electronics and Communication Engineering

The Bachelor of Engineering Programme in Electronics and Communication Engineering [B.E. (E&C)] during four years term, aims to

I. provide the students with strong fundamental and advanced knowledge in mathematics, science and engineering with respect to Electronics and Communication Engineering discipline with an emphasis to solve engineering problems

II. prepare the students through well - designed curriculum to excel in bachelor degree programme in E&C Engg. in order to engage in teaching or industrial or any technical profession and to pursue higher studies

III. train students with intensive and extensive engineering knowledge and skill so as to understand, analyze, design and create novel products and solutions in the field of electronics and communication engineering.

IV. inculcate in students the professional and ethical attitude, effective communication skills, team spirit, multidisciplinary approach and ability to relate engineering issues to broader social context.

V. provide students with an excellent academic environment to promote leadership qualities, character moulding and lifelong learning as required for a successful professional carreer.

3. Develop the programs to implement bit level logical operation. – L5
4. Demonstrate the use of conditional CALL and RETURN instructions. – L3
5. Write the programs to achieve code conversions. – L3
6. Develop the programs to use the DOS interrupts to accept character from keyboard and display. – L5
7. Write the 8051 – assembly language programs for implementing logical and arithmetic operations. – L3
8. Develop the programs to generate sine, square, triangular, ramp waveforms using DAC interface. – L5
9. Demonstrate the interfacing of seven segment LED display, Keypad and stepper motor. – L3

Topic Learning Outcomes

After conducting the experiment the student is able to

1. Write the 8086 – assembly language programs using data movement instructions –MOV, PUSH, POP, XCHG, XLAT, IN, OUT, LEA, LDS, LES, LSS, LGS, LFS, LAHF, SAHF, LODS, SDOS, MOVS, INS, OUTS. – L3
2. Apply the 8086 instructions to perform register addition, immediate addition, memory to register addition, array addition, increment addition, addition with carry, Register subtraction, immediate subtraction, decrement subtraction, subtraction with barrow, comparison, 8 and 16 bit Multiplication 8bit,16 bit,32 bit division, DAS, DAA, AAA, AAD, AAM, AAS. – L3
3. Write the 8086 – assembly language programs to perform 8 bit,16 bit,32 bit up/ down binary and decimal counters. – L3
4. Develop the programs to implement bit level logical operation using AND, OR, XOR, TEST, NOT, NEG. – L5
5. Demonstrate the difference between Near CALL, Far CALL, CALLs with register operands, CALLs with indirect memory addresses, and RET instructions. – L3
6. Write the 8086 – assembly language programs to perform code conversions – Binary to ASCII, ASCII to Binary, ASCII to Hexadecimal, Hexadecimal to ASCII, Binary to BCD, BCD to Binary, BCD to Seven segment. – L3
7. Develop the programs to use the DOS interrupts to accept character from keyboard and display. – L5
8. Write the 8051 – assembly language programs to find out the largest number, to set the particular bits of given port, to swap the nibbles of any two registers, to complement the lowest nibble of a particular RAM location. – L3
9. Demonstrate the interfacing knowledge with KEIL IDE. – L3
10. Write the 8051 – assembly language programs to display the letters and numbers on seven segment LED display. – L3
11. Write the 8051 – assembly language programs to display the key number/letter which is pressed. – L3
12. Develop the programs to generate sine, square, triangular, ramp waveforms using DAC interface. – L5
13. Develop the programs to interface and rotate the stepper motor either clockwise or anti–clockwise. – L5

Course Code : P13ECL48	Semester : IV	L - T - P : 0 - 0 - 1.5
Course Title : MICROPROCESSOR AND MICROCONTROLLER LABORATORY		
Contact Period: Lecture: 36 Hr, Exam: 3 Hr	**Weightage:CIE:50% SEE:50%**	
Prerequisite course for : NIL		

Course Learning Objectives (CLOs)

This course aims to
1. Expose the features of the software tool – MASM simulator.
2. Demonstrate the arithmetic and data transfer instructions of 8086.
3. Write the assembly language programs for counters and code conversions.
4. Demonstrate the application of DOS interrupts.
5. Develop the 8051 assembly language programs for simple logical and arithmetic operations.
6. Demonstrate the interfacing knowledge with KEIL IDE

Course Content

EXPERIMENTS:

Assembly language programming exercises for 8086 – Microprocessor Using MASM for the following
1. Data Transfer – Block move, Exchange, Sorting, Finding largest element in an array
2. Arithmetic Instructions – Addition/subtraction, multiplication and division, Square, Cube (16 bits Arithmetic operations – bit addressable).
3. Binary and decimal Counters
4. Bit level Logical operation.
5. Conditional CALL and RETURN
6. Code conversion: BCD – ASCII; ASCII – Decimal; Decimal – ASCII; HEX – Decimal and Decimal – HEX
7. Use of DOS interrupts to accept character from keyboard and display.

Assembly language programming exercises for 8051 – Microcontroller using Keil software for the following

8. AND,OR,XOR,NOT (Bit level logical),rotate and swap operations
9. Incrementing, decrementing**,** Addition, subtraction, multiplication and division operations (signed)

Assembly language programming exercises for 8051 – Microcontroller using Keil software and Flash magic for the following interfacing modules

10. Seven Segment LED display and Keypad,
11. DAC
12. Stepper motor

Course Outcomes

After conducting all the experiments, the student is able to
1. Write the 8086 – assembly language programs to perform data transfer and arithmetic operation. – L3
2. Write the 8086 – assembly language programs to demonstrate the operations of binary up and down as well as decimal up and down counters. – L3

B) Programme Outcomes (POs)

of Bachelor of Engineering Programme in Electronics and Communication Engineering

The Bachelor of Engineering Programme in Electronics and Communication Engineering [B.E. (E&C)] must demonstrate that its graduates have

a. an ability to apply knowledge of mathematics, science and engineering to develop both analog and digital electronic and communication circuits and systems including software and hardware entities.
b. an ability to design and construct analog and digital electronic circuits, and to conduct experimentson them to analyze and interpret data.
c. an ability to design simulate and fabricate electronic and communication systems, components, devices as well as to design and simulate the analog and digital processes of physical world.
d. an ability to function effectively as an individual and as a member of engineering teams ofelectrical, computer, information, automobile, mechanical and other disciplines.
e. an ability to identify, formulate and solve the problems of both analog and digital electronic and communication circuits and systems including software and hardware entities.
f. an understanding of professional and ethical responsibility at local, national and international levels.
g. an ability to effectively communicate orally and in writing on social and technical occasions in local and global scenarios.
h. the broad education to understand the impact of engineering solutions in a global and societalcontext.
i. an ability to engage in independent and lifelong learning in the broad context of technological change.
j. a knowledge of contemporary issues at local , national and international levels.
k. an ability to use the techniques, skills and modern engineering hardware and soft ware tools which are necessary for engineering practice.

These programme outcomes (POs) are achieved through an array of courses. To ensure the achievement of POs, the course learning outcomes (CLOs) are so formulated that they address the POs.

P.E.S.COLLEGE OF ENGINEERING, MANDYA-571401 (An Autonomous Institution Under VTU. Belgaum)									
Department of Electronics & Communication Engineering. III Semester B.E. (E&C) Scheme Of Teaching And Examination: 2013-14									
Sl No	Course Code	Course Title	Teach-ing Dept.	Hours / Week L:T:P:H	Credit	Examination Marks			Exam Dura-tion in hours
						CIE	SEE	Total Marks	
1.	P13MAT31	Engineering Mathematics-III	Maths	4:0:0:4	4	50	50	100	3
2.	P13EC32	FET and Op-Amp Circuits	E&C	4:0:0:4	4	50	50	100	3
3.	P13EC33	Digital Circuits Design	E&C	4:0:0:4	4	50	50	100	3
4.	P13EC34	Measurements and Instrumentation	E&C	4:0:0:4	4	50	50	100	3
5.	P13EC35	Electrical Network Analysis	E&C	2:1:0:4	3	50	50	100	3
6.	P13EC36	Fundamentals of Signals	E&C	4:0:0:4	4	50	50	100	3
7.	P13ECL37	FET and Op-Amp Circuits Laboratory	E&C	0:0:3:3	1.5	50	50	100	3
8.	P13ECL38	Digital Circuits Design Laboratory	E&C	0:0:3:3	1.5	50	50	100	3
9	P13HU39	Aptitude Competence and Professional Augmentation – I (ACPA – I)	HS & M	2:0:0:2	0	(50)	---	---	---
10	P13ECL310	Industry Interaction – I	E&C	0:0:1:1	0	(50)	---	---	---
11	P13HM311	Constitution of India & Professional Ethics	Human& Science	2:0:0:2	0	(50)	---	---	---
12	P13MADIP31	Additional Maths-I	Maths	4:0:0:4	0	(50)	---	---	--
13	P13HUDIP39	English & Persona Evolution#	HS&M	4:0:0:4	[2]#	[50]#	[50]#	[100]#	3
Total			---	---	26[28]	400 [450]	400 [450]	800 [900]	---

L: Lecture, T: Tutorial, P: Practical, H: Hrs/ Week, CIE: Continuous internal evaluation, SEE semester end Examination, C: Credits.
ACPA- I All students shall have to pass this mandatory learning courses before completion of V - Semester. #English & Persona Evolution Lateral entry students shall have to pass these Credit courses before completion of V- Semester. *Additional Mathematics-I and Constitution of India & professional Ethics Lateral entry students shall have to pass these mandatory learning courses before completion of V- Semester.

Course Assessment Matrix (CAM)

Course Outcome (CO)		Program Outcome (ABET/NBA-(3a-k))										
		a	b	c	d	e	f	g	h	i	j	k
Sketch the V–I characteristics of SCR and TRIAC.	L3	2	2	-	-	-	-	-	-	-	-	-
Sketch the transfer characteristics and output characteristics of IGBT.	L3	2	2	-	-	-	-	-	-	-	-	-
Sketch the graph of α versus Vdc in RC triggering circuit for HWR and FWR.	L3	2	2	-	-	-	-	-	-	-	-	-
Produce the firing pulses to control the firing of the thyristor.	L3	3	2	1	-	-	-	-	-	-	-	-
Produce the firing pulses to control the output voltage of SCR.	L3	3	2	1	-	-	-	-	-	-	-	-
Calculate the RMS output for the different firing angles in AC voltage controllers using TRIAC–DIAC combination.	L4	3	3	3	-	2	-	-	-	-	-	-
Sketch the graph of R versus α for a 1–phase FWR with R and R–L load.	L3	2	2	-	-	-	-	-	-	-	-	-
Compare the duty cycles for PWM DC and FM DC.	L4	3	1	1	-	1	-	-	-	-	-	-
Sketch the graph of α versus Vdc in the case of speed control of DC motor.	L3	2	2	-	-	-	-	-	-	-	-	-
Show the graph of α versus RPM in the case of speed control of DC motor.	L3	2	2	-	-	-	-	-	-	-	-	-
Sketch the graph of R versus α in case of speed control of an Induction motor.	L3	2	2	-	-	-	-	-	-	-	-	-
Show the graph of R versus RPM in case of speed control of an Induction motor.	L3	2	2	-	-	-	-	-	-	-	-	-
Calculate the DC output voltage with and without free–wheeling diodes in a series and parallel inverter.	L4	3	3	3	-	2	-	-	-	-	-	-

1 – Low, 2 – Moderate and 3 – High

Course Articulation Matrix (CAM)

Course Outcome (CO)		Program Outcome (ABET/NBA-(3a-k)) a	b	c	d	e	f	g	h	i	j	k
Sketch the V–I characteristics of SCR and TRIAC.	L3	M	M	-	-	-	-	-	-	-	-	-
Sketch the transfer characteristics and output characteristics of IGBT.	L3	M	M	-	-	-	-	-	-	-	-	-
Sketch the graph of α versus Vdc in RC triggering circuit for HWR and FWR.	L3	M	M	-	-	-	-	-	-	-	-	-
Produce the firing pulses to control the firing of the thyristor.	L3	H	M	L	-	-	-	-	-	-	-	-
Produce the firing pulses to control the output voltage of SCR.	L3	H	M	L	-	-	-	-	-	-	-	-
Calculate the RMS output for the different firing angles in AC voltage controllers using TRIAC–DIAC combination.	L4	H	H	H	-	M	-	-	-	-	-	-
Sketch the graph of R versus α for a 1–phase FWR with R and R–L load.	L3	M	M	-	-	-	-	-	-	-	-	-
Compare the duty cycles for PWM DC and FM DC.	L4	H	L	L	-	L	-	-	-	-	-	-
Sketch the graph of α versus Vdc in the case of speed control of DC motor.	L3	M	M	-	-	-	-	-	-	-	-	-
Show the graph of α versus RPM in the case of speed control of DC motor.	L3	M	M	-	-	-	-	-	-	-	-	-
Sketch the graph of R versus α in case of speed control of an Induction motor.	L3	M	M	-	-	-	-	-	-	-	-	-
Show the graph of R versus RPM in case of speed control of an Induction motor.	L3	M	M	-	-	-	-	-	-	-	-	-
Calculate the DC output voltage with and without free–wheeling diodes in a series and parallel inverter.	L4	H	H	H	-	M	-	-	-	-	-	-

L- Low, M- Moderate, H-High

P.E.S.COLLEGE OF ENGINEERING, MANDYA-571401
(An Autonomous Institution Under VTU. Belgaum)
Department of Electronics & Communication Engineering.
IV Semester B.E.(E&C) SCHEME OF TEACHING AND EXAMINATION:2013-14

Sl No.	Course Code	Course Title	Teaching Dept.	Hours /Week L:T:P:H	Credit	Examination Marks CIE	SEE	Total Marks	Exam Duration in hours
1.	P13MA41	Engineering Mathematics-IV (HC)	Maths	4:0:0:4	4	50	50	100	3
2.	P13EC42	Analog Communication Theory(HC)	E&C	4:0:0:4	4	50	50	100	3
3.	P13EC43	Industrial Electronics (HC)	E&C	4:0:0:4	4	50	50	100	3
4.	P13EC44	Digital Signal Processing (HC)	E&C	4:0:0:4	4	50	50	100	3
5.	P13EC45	Microprocessor and Microcontroller (HC)	E&C	4:0:0:4	4	50	50	100	3
6.	P13EC46	Electromagnetics and Antennas (HC)	E&C	2:1:0:3	3	50	50	100	3
7.	P13ECL47	Industrial Electronics Laboratory	E&C	0:0:3:3	1.5	50	50	100	3
8.	P13ECL48	Microprocessor and Microcontroller Laboratory	E&C	0:0:3:3	1.5	50	50	100	3
9	P13HU49	Aptitude Competence and Professional Augmentation – II (ACPA – II)	HS & M	2:0:0:2	0	(50)	---	---	---
10	P13ECL410	Mini Project-I	E&C	0:0:1:1	0	(50)	--	--	--
11.	P13MADIP41	Additional Maths-II	Maths	4:0:0:4	0	(50)	--	--	--
12.	P13EV49	Environmental Studies	ENV	2:0:0:2	0	(50)	--	--	--
		Total			26	400	400	800	

L: Lecture, T: Tutorial, P: Practicals, CIE: Continuous Internal Evaluation, SEE: Semester End Examination, C: Credits
* Additional Mathematics-II & Environmental Studies : Lateral entry students shall have to pass these mandatory learning courses before completion of VI- Semester.
** Aptitude Development : All students shall have to pass this mandatory learning courses before completion of VI- Semester

Evaluation Scheme
(For Theory Courses only)

Scheme	Weightage	Marks	Event Break Up				
			Test I	Test II	Quiz I	Quiz II	Assign-ment
CIE	50%	50	35	35	5	5	10
SEE	50%	100	Questions to Set: 10		Questions to Answer: 5		

A. Scheme of SEE Question Paper (100 Marks)

Duration: 3Hrs	Marks: 100	Weightage: 50%

Each of the two questions set shall be so comprehensive as to cover the entire contents of the unit.
There will be direct choice between the two questions within each Unit
Total questions to be set are 10. All carry equal marks of 20
The no of subdivisions in each main question shall be limited to three only
No of questions to be answered by students is 5

6. Calculate the RMS output for the different firing angles in AC voltage controllers using TRIAC–DIAC combination. – L4
7. Sketch the graph of R versus α for a 1–phase FWR with R and R–L load. – L3
8. Compare the duty cycles for PWM DC and FM DC. – L4
9. Sketch the graph of α versus Vdc in the case of speed control of DC motor. – L3
10. Show the graph of α versus RPM in the case of speed control of DC motor. – L3
11. Sketch the graph of R versus α in case of speed control of an Induction motor. – L3
12. Show the graph of R versus RPM in case of speed control of an Induction motor. – L3
13. Calculate the DC output voltage with and without free–wheeling diodes in a series and parallel inverter. – L4

Course Code : P13ECL47	Semester : IV	L - T - P : 0 - 0 - 1.5
Course Title : INDUSTRIAL ELECTRONICS LABORATORY		
Contact Period: Lecture: 36 Hr, Exam: 3 Hr	**Weightage:CIE:50% SEE:50%**	
Prerequisite course for : NIL		

Course Learning Objectives (CLOs)

This course aims to

1. Provide the basic knowledge of how to use Power Devices, Bread board, Power Supply, Ammeters, Voltmeters and other Devices and how to rig up the circuits.
2. Obtain the Static Characteristics of SCR and TRIAC.
3. Obtain the Static Characteristics of IGBT.
4. Design the Controlled HWR and FWR using RC Triggering circuit.
5. Use the Digital Firing Circuit to trigger SCR.
6. Design the Synchronized UJT Firing Circuit for HWR and FWR circuits.
7. Design the AC Voltage Controller using TRIAC–DIAC combination.
8. Design the Single–Phase FWR with R and R–L loads.
9. Design the Impulse Commutated Chopper.
10. Demonstrate the working of Separately Excited Motor.
11. Demonstrate the working of a Single Phase Induction Motor.
12. Demonstrate the working of Parallel Inverter.
13. Demonstrate the working of Series Inverter.

Course Content

EXPERIMENTS:

1. Static characteristics of SCR and TRIAC.
2. Static characteristics of IGBT.
3. Design of controlled HWR and FWR using RC triggering circuit.
4. Digital Firing Circuit to trigger SCR.
5. Design of Synchronized UJT firing circuit for HWR and FWR circuits.
6. Design of AC voltage controller using TRIAC – DIAC combination.
7. Design of Single phase FWR with R and R–L loads.
8. Voltage (Impulse) commutated chopper – both constant frequency and variable Frequency operations.
9. Speed control of separately excited DC motor.
10. Speed control of single phase induction motor.
11. Demonstration of parallel inverters.
12. Demonstration of series inverters.

Course Outcomes

After conducting all the experiments the student is able to

1. Sketch the V–I characteristics of SCR and TRIAC. – L3
2. Sketch the transfer characteristics and output characteristics of IGBT. – L3
3. Sketch the graph of α versus Vdc in RC triggering circuit for HWR and FWR. – L3
4. Produce the firing pulses to control the firing of the thyristor. – L3
5. Produce the firing pulses to control the output voltage of SCR. – L3

Course Code : P13EC32	Semester : III	L - T - P : 4 - 0 - 0
Course Title : FET AND OP–AMP CIRCUITS		
Contact Period: Lecture: 52 Hr, Exam: 3 Hr	**Weightage:CIE:50% SEE:50%**	

Prerequisite course for :

1. Digital CMOS VLSI Design – P13EC52
2. Analog CMOS VLSI Design – P13EC64
3. Low Power VLSI Design – P13EC72

Course Learning Objectives (CLOs)

This course aims to

1. Provide the basic knowledge of N-MOSFET, P-MOSFET, device structure, MOSFET circuit at DC, MOSFET as an amplifier and as a switch.
2. Explain how to bias the MOSFET amplifier circuits, small signal operations and models, frequency response of CS amplifier.
3. Explain the basics of Op–Amp and its use in DC and AC amplifiers.
4. Explain the applications of Op-Amp like inverting amplifier, non–inverting amplifier, voltage follower, summing amplifier and difference amplifier.
5. Explain the voltage sources, current sources and current amplifiers.
6. Explain the Op–Amp frequency response, compensation and applications.
7. Describe the operation of differentiating, integrating and Schmitt trigger circuits.
8. Describe the rectifiers, clippers, clampers, monostable and astable multi–vibrators.
9. Discuss how the Op–Amps are used in signal generators, filters and regulators.
10. Explain how the Op-Amps are used as DC voltage regulators.

Course Content

UNIT – I

MOS Field – Effect Transistors (MOSFETs): Introduction, Device Structure and Physical Operation, Current – Voltage Characteristics, MOSFET Circuits at DC, The MOSFET as an Amplifier and as a Switch, Biasing in MOS Amplifier Circuits, Small Signal Operation and Models, Basic MOSFET amplifier configurations – The three basic configurations, Characterizing Amplifiers, The Common Source Amplifier, Frequency Response of the CS Amplifier, The Depletion–Type MOSFET.

Text1: 4.1 to 4.6, 4.7.1 to 4.7.3, 4.9, 4.14 **10 Hrs**

UNIT – II

Operational Amplifier Fundamentals: IC Operational amplifiers, Op–Amp parameters – Input, output and supply voltages, offset voltages and currents, Input and output impedances, Slew rate and Frequency limitations. Op–Amps as DC Amplifiers– Biasing Op–Amps, Direct coupled –Voltage Followers, Direct–Coupled Non–inverting Amplifiers, Direct–Coupled Inverting amplifiers, Summing amplifiers, Difference amplifier, Instrumentation Amplifier

Op–Amps as AC Amplifiers: Capacitor coupled Voltage Follower, High input impedance – Capacitor coupled Voltage Follower, Capacitor coupled Non–inverting Amplifiers, High input impedance – Capacitor coupled Non–inverting Amplifiers.

Text 2: 1.1, 2.3, 2.4, 2.5, 2.6, 3.1, 3.2, 3.3, 3.4, 3.6, 3.7, 3.8, 4.1 to 4.4 **11 Hrs**

UNIT – III

Capacitor coupled Inverting amplifiers, setting the upper cut–off frequency, Capacitor coupled Difference amplifier, Use of a single polarity power supply.

Op–Amps frequency response and compensation: Circuit stability, Frequency compensation methods, Circuit Band width and Slew rate, circuit stability precautions.

OP–AMP Applications: Voltage sources, current sources and current sinks, Current amplifiers.

Text 2: 4.5 to 4.8, 5.1, 5.2, 5.4, 5.6, 7.1, 7.2, 7.3 **10 Hrs**

UNIT – IV

Differentiating and Integrating Circuits: voltage level detectors, inverting Schmitt trigger circuits Differentiating Circuit, Integrating Circuit.

Signal Processing Circuits: Precision Half–Wave Rectifiers: Saturating Precision Rectifier and Nonsaturating Precision Rectifier, Precision Full–Wave Rectifiers, Limiting circuits: Peak Clipper and Dead Zone Circuit, Clamping circuits, Peak detectors, sample and hold circuits, Astable Multivibrator and Monostable

Text 2:, 8.2, 8.3, 8.6, 8.7, 9.1 to 9.6, 10.1, 10.2 **10 Hrs**

UNIT – V

Signal Generators: Triangular wave generators, phase shift and quadrature oscillator, Wein bridge oscillator, Active Filters –First and second order Low pass & High pass filters.

DC Voltage Regulators: Voltage Regulator Basics, op–amp series voltage Regulator, Adjustable Output Regulator, Integrated Circuit linear Voltage Regulators: 723, LM317and LM337 IC Regulators.

Text2:10.3, 11.1, 11.3, 12.2, 12.3, 13.1, 13.2, 13.3, 13.5 **11 Hrs**

TEXT BOOKS:

1. "Microelectronic Circuits Theory and Applications", Adel S. Sedra, Kenneth C. Smith Adapted by Arun N. Chandorkar, 6th Edition International Version, Oxford.
2. "Operational Amplifiers and Linear IC's", David A. Bell, 3rd edition, Oxford university Press, 2011.

REFERENCE BOOKS:

1. "Electronic Devices and Circuit Theory", Robert L. Boylestad and Louis Nashelsky, PHI, 9th Edition.
2. "Linear Integrated Circuits", D. Roy Choudhury and Shail B. Jain, 2nd edition, Reprint 2006, New Age International.
3. "Op – Amps and Linear Integrated Circuits", Ramakant A. Gayakwad, 4th edition, PHI.
4. "Operational Amplifiers and Linear Integrated Circuits", Robert. F. Coughlin & Fred.F. Driscoll PHI/Pearson, 2006.
5. "Op – Amps and Linear Integrated Circuits", James M. Fiore, Thomson Learning, 2001.
6. "Design with Operational Amplifiers and Analog Integrated Circuits", Sergio Franco, TMH, 3rd edition, 2005.

Course Assessment Matrix (CAM)

Course Outcome (CO)		Program Outcome (ABET/NBA-(3a-k))										
		a	b	c	d	e	f	g	h	i	j	k
Analyze the static electric field using coulomb's law, Gauss law, Laplace's and poison's equations. (Unit – I)	L4	3	2	-	-	-	-	-	-	-	-	-
Compute the static electric field intensity and potential due to different charge distributions. (Unit – I)	L3	2	2	2	-	2	-	-	-	-	-	-
Analyze the steady magnetic field using Biot – Savart's law, Ampere's law and Stoke's theorem. (Unit–II)	L4	3	2	-	-	-	-	-	-	-	-	-
Compute the force between differential current element and inductances. (Unit – III)	L3	2	2	2	-	2	-	-	-	-	-	-
Explain the properties of TEM waves in free space, conductors and dielectric medium.(Unit – IV)	L2	3	1	-	-	-	-	-	-	-	-	-
Explain the ground wave, space wave and sky wave propagations. (Unit – V)	L2	3	1	-	-	-	-	-	-	-	-	-
1 – Low, 2 – Moderate and 3 – High												

Course Articulation Matrix (CAM)												
Course Outcome (CO)		**Program Outcome** (ABET/NBA-(3a-k))										
		a	**b**	**c**	**d**	**e**	**f**	**g**	**h**	**i**	**j**	**k**
Analyze the static electric field using coulomb's law, Gauss law, Laplace's and poison's equations. (Unit – I)	L4	H	M	-	-	-	-	-	-	-	-	-
Compute the static electric field intensity and potential due to different charge distributions. (Unit – I)	L3	M	M	M	-	M	-	-	-	-	-	-
Analyze the steady magnetic field using Biot – Savart's law, Ampere's law and Stoke's theorem. (Unit–II)	L4	H	M	-	-	-	-	-	-	-	-	-
Compute the force between differential current element and inductances. (Unit – III)	L3	M	M	M	-	M	-	-	-	-	-	-
Explain the properties of TEM waves in free space, conductors and dielectric medium.(Unit – IV)	L2	H	L	-	-	-	-	-	-	-	-	-
Explain the ground wave, space wave and sky wave propagations. (Unit – V)	L2	H	L	-	-	-	-	-	-	-	-	-
L- Low, M- Moderate, H-High												

Course Outcomes

After learning all the units of the course, the student is able to

1. Describe the working of MOSFETs and biasing circuits. – L1 (Unit – I)
2. Explain the single–stage MOS amplifier and its frequency response. – L2 (Unit – I)
3. Analyze the working of instrumentation amplifier and AC amplifier – L4 (Unit – II)
4. Differentiate the operations of voltage sources, current sources, current sinks and current amplifiers.– L4 (Unit – III)
5. Relate the different waveforms generated using precision rectifiers, limiting circuits, clamping circuits, peak detectors and sample & hold circuits, differentiating and integrating circuits. – L3 (Unit – IV)
6. Compare the operations of voltage follower regulator, adjustable output regulator, precision voltage regulator and IC voltage regulator. – L4 (Unit – V)

Topic Learning Outcomes

After learning all the topics of UNIT – I, the student is able to

1. Distinguish the MOSFET and BJT devices. – L2
2. Explain the device structure and physical operations of MOSFETs. – L2
3. Explain the Current-Voltage characteristics of MOSFETs. –L1
4. Describe the MOSFET as an amplifier and as a switch. – L2
5. Explain the biasing in MOS amplifier circuits. – L2
6. Describe the small signal operation of MOSFETs. – L2
7. Outline the MOSFET models. – L1
8. Describe the single–stage MOS amplifiers, basic structure and characterizing amplifiers. – L1
9. Describe the common source amplifier and frequency response of the CS Amplifier. – L1
10. Explain the depletion–type MOSFET. – L2

After learning all the topics of UNIT – II, the student is able to

1. Explain the basic characteristics of Op–Amp circuit. – L2
2. Describe the various Op-Amp parameters. – L1
3. Describe how to find the input and output impedance. – L1
4. Explain the slew rate and frequency limitations. – L2
5. Discuss the biasing of Op-Amps. – L2
6. Explain how the Op–Amp is used as voltage follower. – L2
7. Differentiate between the non–inverting and inverting amplifiers. – L4
8. Describe the working of summing and difference amplifiers. – L2
9. Explain the working of instrumentation amplifier. – L2
10. Explain the operation of Op–Amp as AC amplifier. – L2

After learning all the topics of UNIT – III, the student is able to

1. Show how the upper cut–off point can be set to any desired frequency for an op –amp circuit and use of single polarity power supply. – L3
2. Show how the feedback in Op–Amp circuits can produce instability and state the condition that produces oscillations. – L3
3. Sketch the circuit for lag, lead and miller–effect compensation. –L3
4. Explain the lag, lead and miller–effect compensation and how each affects the Op–Amp frequency response. – L2

5. Calculate the slew rate–limited frequency and the slew rate–limited rise time for given Op–amp output amplitude. – L4
6. Calculate the slew rate–limited amplitude at the circuit cut–off frequency. – L4
7. Explain how the Zin mod method can be employed to extend the bandwidth of an Op–Amp circuit. – L2
8. List the precautions that should be observed for operational amplifier circuit stability. – L1
9. Explain the operation of voltage sources and current sources. – L2
10. Describe the operation of current sinks and current amplifiers. – L2

After learning all the topics of UNIT – IV, the student is able to

1. Explain the working of voltage level detector. – L2
2. Design the inverter schmitt trigger circuits. – L5
3. Sketch the Op–Amp differentiating and integrating circuits. – L3
4. Explain the operation of differentiating and integrating circuits. – L2
5. Explain the operation of precision half wave and full wave rectifiers. – L2
6. Differentiate between the clipping and clamping circuits. – L4
7. Describe the operation of Dead zone Circuit.– L2
8. Explain the operation of peak detectors. – L2
9. Explain the operation of sample & hold circuits. – L2
10. Describe the working of monostable & astable multivibrator. – L2

After learning all the topics of UNIT – V, the student is able to

1. Describe the working of triangular wave generator.– L2
2. Design the phase shift and quadrature oscillator.– L5
3. Describe the wein bridge oscillator.– L2
4. Design the first and second order low-pass filters.– L5
5. Design the first and second order high-pass filters.– L5
6. Explain the basics of a voltage regulator. – L2
7. Explain the working of an Op-Amp series voltage regulator. – L2
8. Define the line regulation, load regulation and ripple rejection. – L1
9. Explain the operation of adjustable output regulator. – L2
10. Sketch the basic circuit of a LM317 and LM337 IC regulators. – L3

Review Questions

1. Differentiate between the MOSFET and BJT devices.
2. Explain the device structure and physical operations of MOSFETs.
3. Draw and explain the Current-Voltage characteristics of MOSFET.
4. Describe the MOSFET as an amplifier and as a switch.
5. An enhancement-type N-MOS transistor with V_t = 0.7 V has its source terminal grounded and 1.5 V dc applied to the gate. In what region does the device operate for (a) V_D = 0.5 V, (b) V_D = 3 V.
6. Explain the biasing in MOS amplifier circuits.
7. Describe the small signal operation of MOSFETs.
8. Draw and explain the single–stage MOS amplifiers circuits.
9. Describe the common source amplifier and its frequency response.
10. With diagram explain the depletion–type MOSFET.
11. Mention the ideal characteristics of Op–Amp.
12. Define the following parameters (a) Slew rate (b) CMRR (c) PSSR.

38. Antenna Basics : Basic Antenna parameters
39. patterns, beam area, radiation intensity, beam efficiency and diversity and gain
40. Directivity and resolution, antenna apertures, effective height, bandwidth and the radio communication links
41. Fields from Oscillating Dipole, antenna field zones and Shape–Impedance considerations
42. Test - II

UNIT–V

43. **Radiation:** Introduction, Basic Maxwell's Equation, Retarded (Time Varying) Potential, Far Field Due to an Alternating Current Element(Oscillating Dipole),
44. Electrostatic Field, Induction Field, Hertzian Dipole, Power Radiated by a Current Element, Far Field due to Sinusoidal Current Distribution, Near Far Field due to Sinusoidal Current Distribution.
45. **Ground Wave Propagation:** Introduction, Plane Earth Reflection, Space Wave and Surface Wave, Transition Between Surface and Space Wave, Tilt of Wave Front due to Ground Losses,
46. Impact of Imperfect Earth, Reduction Factor and Numerical Distance, Earth's Behavior at Different Frequencies, Electrical Properties of the Earth, Curved Earth Reflection.
47. **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, Absorption by Atmospheric Phenomena,
48. Variation of Field Strength with Height, Super Refraction, Meteorological Conditions Predicting Super Refraction, Scattering Phenomena, Tropospheric Propagation, Fading, Path Loss Calculations.
49. **Sky Wave Propagation:** Introduction, Structural Details of the Ionosphere, Wave Propagation Mechanism, Refraction in The Absence of Earth's Magnetic Field,
50. Refraction in the Presence of the Earth's Magnetic Field,
51. 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, Impact of Solar Activity, Multi – Hop Propagation, Take –Off Angle, Energy Loss in Ionosphere and Sky Wave Signal Strenght,
52. Primary and Secondary Services, Wave Characteristics, VLF Wave Propagation, VHF(metric) Waves, UHF (decimetric) and SHF (centimetric) Waves, EHF (millimetric) Waves, Sub – Millimetric and Optical Waves.

Lesson Plan

UNIT–I

1. Coulomb’s Law and Eletric Field Intensity: Experimental law of Coulomb
2. Electric field intensity
3. Field due to continuous volume charge
4. Line charge and sheet charge
5. Electric Flux Density, Gauss’s Law and Divergence: Introduction
6. Electric flux density
7. Gauss law
8. Application of Gauss Law
9. Divergence and divergence theorem
10. Problems on Electric Flux Density, Gauss’s Law and Divergence

UNIT–II

11. Energy and Potential: Energy expended in moving a point charge in an electric field
12. Line integral and definition of potential difference and potential
13. Potential field of point charge and a system of charges
14. Potential gradient, Dipole, energy density in an electric field
15. Poisson’s and Laplace’s Equations: Poisson's and Laplace’s equations
16. Uniqueness Theorem
17. Examples of the solutions of Laplace’s and Poisson’s equations
18. The Steady Magnetic Field: Biot– Savart law and Ampere’s circuital law
19. Curl, Stokes theorem and magnetic flux and flux density
20. Scalar and vector magnetic potentials
21. Test - I

UNIT – III

22. Magnetic Forces, Materials and Inductance: Force on a moving charge and differential current element
23. Force between differential current element
24. Force and torque on closed circuit and magnetization and permeability
25. Magnetic boundary conditions
26. Potential energy and forces on magnetic materials
27. Self inductance and mutual inductance
28. Time–Varying Fields and Maxwell’s Equations: Faraday's law
29. Displacement current
30. Maxwell's equations in point and integral form
31. Retarded potentials

UNIT – IV

32. The Uniform Plane Wave: Uniform plane wave
33. Wave propagation in free space and dielectrics and poynting vector and power considerations
34. Propagation in good conductors (skin effect) and Wave polarization
35. Plane Wave Reflection and Dispersion: Reflection of uniform plane waves at normal incidence
36. SWR and Wave Reflection from Multiple Interfaces
37. Plane wave Propagation in general directions

13. Calculate the typical input and output impedance of 741 op-amp employed as a voltage follower.
14. An op-amp circuit is to have a 10 KHZ triangular output waveform with a 12V peak to peak amplitude. Calculate the op-amp minimum slew rate.
15. Discuss the biasing of Op-Amps.
16. Explain how the Op–Amp is used as voltage follower.
17. Differentiate between non–inverting and inverting amplifiers.
18. Describe the working of summing and difference amplifiers.
19. Explain the working of instrumentation amplifier.
20. Explain the operation of Op–Amp as AC amplifier.
21. Show how the upper cut–off point can be set to any desired frequency for an op –amp circuit and use of single polarity power supply.
22. Show how feedback in Op–Amp circuits can produce instability and state the condition that produces oscillations.
23. Sketch the circuit for lag, lead and miller–effect compensation.
24. Explain the lag, lead and miller–effect compensation and how each affects the Op–Amp frequency response.
25. Calculate the slew rate–limited frequency and the slew rate–limited rise time for given Op–amp output amplitude.
26. Calculate the slew rate–limited amplitude at the circuit cut–off frequency.
27. Explain how the Zin mod method can be employed to extend the bandwidth of an Op–Amp circuit.
28. List the precautions that should be observed for operational amplifier circuit stability.
29. Explain the operation of voltage sources and current sources.
30. Describe the operation of current sinks and current amplifiers.
31. Explain the working of voltage level detector.
32. Design the inverter schmitt trigger circuit to give trigger points of ± 2 V.
33. Sketch the Op–Amp differentiating and integrating circuits.
34. Explain the operation of differentiating and integrating circuits.
35. Explain the operation of precision half wave and full wave rectifiers.
36. Differentiate between the clipping and clamping circuits.
37. Describe the operation of Dead zone Circuit.
38. Explain the operation of peak detectors.
39. Explain the operation of sample & hold circuits.
40. Describe the working of monostable & astable multivibrator.
41. Explain how to generate a triangular wave using op-amp.
42. Design the phase shift oscillator circuit to produce 3 KHZ output frequency. The op-amp is to use ± 12 V supply.
43. What is wein bridge oscillator? Explain.
44. Design the first order active low-pass filter to have 1.2 KHZ cut-off frequency.
45. Design the second order high-pass filter circuit to have a cut-off frequency of 6 KHZ.
46. For a voltage regulator define source effect, load effect, line regulation, load regulation and ripple rejection. Write the equation for each item.
47. Draw and explain op-amp dc voltage regulator.
48. Design a voltage regulator circuit to produce a 12 V output with a 50mA maximum load current.
49. Explain the operation of adjustable output regulator.
50. Sketch the basic circuits of LM317 and LM337 IC regulators.

Lesson Plan

Unit – I

1. MOS Field – Effect Transistors (MOSFETs): Introduction
2. Device Structure and Physical Operation
3. Current – Voltage Characteristics
4. MOSFET Circuits at DC, the MOSFET as an Amplifier and as a Switch
5. Biasing in MOS Amplifier Circuits
6. Small Signal Operation and Models
7. Basic MOSFET amplifier configurations – The three basic configurations
8. Characterizing Amplifiers, the Common Source Amplifier
9. Frequency Response of the CS Amplifier
10. The Depletion–Type MOSFET

Unit – II

11. Operational Amplifier Fundamentals: IC Operational amplifiers
12. Op–Amp parameters – Input, output and supply voltages, offset voltages and currents,
13. Op–Amp parameters (continued) – Input and output impedances, Slew rate and Frequency limitations.
14. Op–Amps as DC Amplifiers– Biasing Op–Amps,
15. Direct coupled –Voltage Followers, Non–inverting Amplifiers, Inverting amplifiers,
16. Summing amplifiers, Difference amplifier, Instrumentation Amplifier
17. Op–Amps as AC Amplifiers: Capacitor coupled Voltage Follower,
18. High input impedance – Capacitor coupled Voltage Follower,
19. Capacitor coupled Non–inverting Amplifiers,
20. High input impedance – Capacitor coupled Non–inverting Amplifiers.
21. Test - I

Unit – III

22. Capacitor coupled Inverting amplifiers,
23. Setting the upper cut–off frequency,
24. Capacitor coupled Difference amplifier,
25. Use of a single polarity power supply.
26. Op–Amps frequency response and compensation: Circuit stability,
27. Frequency compensation methods,
28. Circuit Band width and Slew rate,
29. Circuit stability precautions.
30. OP–AMP Applications: Voltage sources, current sources and current sinks,
31. Current amplifiers.

Unit – IV

32. Differentiating and Integrating Circuits: voltage level detectors,
33. Inverting Schmitt trigger circuits
34. Differentiating Circuit, Integrating Circuit.
35. Signal Processing Circuits: Introduction
36. Precision Half–Wave Rectifiers: Saturating Precision Rectifier and Nonsaturating Precision Rectifier,
37. Precision Full–Wave Rectifiers,
38. Limiting circuits: Peak Clipper and Dead Zone Circuit,
39. Clamping circuits, Peak detectors.

33. A 50 MHz uniform plane wave has electric field amplitude 10V/m. The medium is lossless, having $\varepsilon_r = 9$ and $\mu_r = 1$. The wave propagates in the x-y plane at a 30^0 angle to the x-axis and in linearly polarized along z. Write down the phasor expression for electric field. Find λ_x, λ_y, V_{px} and V_{py}.
34. Define the following parameters of antenna:
    - HPBW
    - FNBW
    - Beam solid angle.
37. Define the term directory of an antenna. Calculate the diversity of a source with intensity variation $u = u_m \sin^2\theta \sin^3\varphi$ for $0 \le \theta \le \pi$ and $0 \le \varphi \le \pi$ using appropriate method.
38. Write a note on folded dipole antenna.
39. Define beam width of an antenna and show that its directivity is given by D= $\frac{41253}{\theta_E \varphi_H}$, where θ_E φ_H are half power beam width in E and H Plane respectively.
40. Derive the basic radiation equations and explain the condition for radiation. An antenna has a loss resistance 10Ω, power gain of 20 and directivity 22. Calculate its radiation resistance.
41. In tropospheric propagation define the following:
    - Sub refraction
    - Super refraction
    - Duct propagation.
42. Explain the properties of surface wave propagation.
43. Define the terms Skip distance and Virtual height, derive equation for skip distance in-terms of virtual height.
44. Define the term LOS distance and obtain equation for it. A VHF communication is to be established at 90MHz. If the LOS distance is 40.3 Km and height of a transmitter antenna is 40m calculate the height of receiver antenna.
45. Briefly explain ionospheric propagation and derive equation for dielectric constant.
46. How surface wave propagation takes place? What are the factors affecting the ground wave propagation?
47. Derive the equation for relative permittivity and conductivity of ionosphere.
48. Define and derive the expressions for the following in case of ionospheric propagation:
    - Critical frequency
    - Maximum usable frequency.
49. In an ionospheric wave propagation the angle of incidence made at particular layer, at a height of 200Km is 45^0 with critical frequency 6MHz. Calculate the skip distance.
50. Derive the expression for field strength due to space wave, in-terms of the heights of transmitting and receiving antenna and field strength at unit distance. Plot the variation of field strengths as a function of distance.

15. State and explain Uniqueness Theorem.
16. By using Biot & Savarts law find magnetic field at a point along y-axis for an infinitely long straight filament carrying current I along Z-Direction.
17. Write an equation for total energy stored in a system of four identical point charges Q = 4nC, at the corners of a square 1m on a side. What is the stored energy in the system when only two charges at opposite corners are in place.
18. Given non uniform field E = yâx + xây + Zâz. Find the work expende in carrying 2C from B(1, 0, 1) to A(0.8, 0.6, 1) along:
    - Shorter arc of the circle $x^2 + y^2 = 1$ & Z=1.
    - Straight line path from B to A.
19. Prove that the potential field given by, $V = 2x^2 – 3y^2 + z^2$ satisfies Laplace's equation.
20. An infinitely long coaxial cable carries current I in the inner conductor with internal radius 'a' and area at I in the outer conductor with radii extending from 3a to 4a. Sketch the variation of magnetic field Ĥ as a function of radius r. (note: First Derive equations and the substitute).
21. Starting from Faraday's law show that $\nabla \times E = \frac{-\partial B}{\partial t}$.
22. Write Maxwell's Equation in point form and integral form for time varying and non time varying fields.
23. Explain in detail retarded potentials.
24. Define self-inductance. Find self inductance of a coaxial cable of inner radius 'a' and outer radius 'b'.
25. A loop has a dimension of 1m x 2m (ie., *x* x *y*) and lies along x-y plane with one vertex at the origin. Loop current is 4mA and field is B_0 = - 0.6 ây + 0.8âz T. Find the torque by calculating total force on each side.
26. Derive force between differential current elements.
27. Derive expression for inductance of a:
    - Solenoid
    - Two-wire transmission line.
28. Explain the concept of conduction current density and displacement current density.
29. Define mutual inductance. A solenoid with N_1 = 1000, r_1 = 1cm and l_1 = 50cm in concentric within second coil of N_2 = 2000, r_2 = 2cm and l_2 = 50cm. Find the mutual inductance assuming free space charge conditions.
30. Starting form Maxwell's equation in differential form derive Ampere's Circuital Law in point form for time varying fields.
31. Explain wave propagation in dielectrics.
32. Write explanatory note on the following:
    - Wave polarization
    - Standing waves in lossless medium and VSWR
    - Plane wave propagation in general directions.
33. Explain the propagation of uniform plane wave in free space with necessary equations.
34. What is skin depth? What is its relationship with attenuation constant, conductivity and frequency?

40. Sample and hold circuits
41. Astable Multivibrator and Monostable
42. Test - 2

Unit – V

43. Signal Generators: Triangular wave generators
44. Phase shift and quadrature oscillator
45. Wein bridge oscillator
46. Active Filters – First and second order Low pass filters
47. Active Filters – First and second order High pass filters
48. DC Voltage Regulators: Voltage Regulator Basics
49. Op–amp series voltage Regulator
50. Adjustable Output Regulator
51. Integrated Circuit linear Voltage Regulators: 723
52. LM317and LM337 IC Regulators

Course Articulation Matrix (CAM)

Course Outcome (CO)		Program Outcome (ABET/NBA-(3a-k))										
		a	**b**	**c**	**d**	**e**	**f**	**g**	**h**	**i**	**j**	**k**
Describe the working of MOSFETs and biasing circuits. (Unit – I)	L1	M	M	L	-	-	-	-	-	-	-	-
Explain the single–stage MOS amplifier and its frequency response. (Unit – I)	L2	M	H	-	-	-	-	-	-	-	-	-
Analyze the working of instrumentation amplifier and AC amplifier. (Unit – II)	L4	M	M	H	-	-	-	-	-	-	-	-
Differentiate the operations of voltage sources, current sources, current sinks and current amplifiers.(Unit – III)	L4	M	M	L	-	-	-	-	-	-	-	-
Relate the different waveforms generated using precision rectifiers, limiting circuits, clamping circuits, peak detectors and sample & hold circuits, differentiating and integrating circuits. (Unit – IV)	L3	M	L	-	-	-	-	-	-	-	-	-
Compare the operations of voltage follower regulator, adjustable output regulator, precision voltage regulator and IC voltage regulator. (Unit – V)	L4	M	L	-	-	-	-	-	-	-	-	-

L- Low, M- Moderate, H-High

Course Assessment Matrix (CAM)

Course Outcome (CO)		Program Outcome (ABET/NBA-(3a-k))										
		a	**b**	**c**	**d**	**e**	**f**	**g**	**h**	**i**	**j**	**k**
Describe the working of MOSFETs and biasing circuits. (Unit – I)	L1	1	2	1	-	-	-	-	-	-	-	-
Explain the single–stage MOS amplifier and its frequency response. (Unit – I)	L2	2	3	-	-	-	-	-	-	-	-	-
Analyze the working of instrumentation amplifier and AC amplifier. (Unit – II)	L4	2	2	3	-	-	-	-	-	-	-	-
Differentiate the operations of voltage sources, current sources, current sinks and current amplifiers.(Unit – III)	L4	2	2	1	-	-	-	-	-	-	-	-
Relate the different waveforms generated using precision rectifiers, limiting circuits, clamping circuits, peak detectors and sample & hold circuits, differentiating and integrating circuits. (Unit – IV)	L3	2	1	-	-	-	-	-	-	-	-	-
Compare the operations of voltage follower regulator, adjustable output regulator, precision voltage regulator and IC voltage regulator. (Unit – V)	L4	2	1	-	-	-	-	-	-	-	-	-

1 – Low, 2 – Moderate and 3 – High

4. Discuss the field strength relation, effects of imperfect earth, effects of curvature of earth, effects of interference zone. – L2
5. Explain the shadowing effect of hills and buildings ,absorption by atmospheric phenomena, variation of field strength with height, super refraction, meteorological Conditions predicting super refraction ,scattering phenomena. – L2
6. Explain the structural details of the ionosphere, wave propagation mechanism, refraction in the absence of the earth's magnetic field. – L2
7. Develop the equation for critical frequency, MUF, LUF, OF, virtual height and skip distance. – L5
8. Discuss the relation between MUF and the skip distance, impact of solar activity, multi–hop propagation and take off angle. – L2
9. Explain the energy loss in ionosphere and sky wave, signal strength, primary and secondary services and wave characteristics. – L2
10. Discuss the VIF wave propagation, VHF waves, UHF and SHF waves, EHF waves, sub–milli–metric and optical waves. – L2

Review Questions

1. Define Electric Field Intensity due to point charge in vector form. With usual notations derive expressions for field at a point due to many charges.
2. State and prove Gauss Law.
3. State and prove Divergence theorem.
4. Prove that the Divergence of the electric field and that of Electric flux density in a charge free region is zero.
5. State Divergence theorem of D=2xy âx + x^2 ây C/m^2 & rectangular parallel piped formed by x=0 & 1, y=0 & 2 and z=0 & 3. Find Q enclosed using Divergence theorem.
6. Find the electric field E at the origin, if the following charge distributions are present in free space.
   - Point charge 12nC at P(2, 0, 6)
   - Uniform line charge of linear charge density 3nC/m at x=2, y=3
   - Uniform surface charge density of 0.2nC/m^2 at x=2.
7. Find the total charge contained in a 2cm length electron beam oriented along z-direction with radius 1cm and volume charge density $\rho_v = -5 \times 10^{-5\rho_z}$ $\mu C/m^3$ *(assume 2cm ∟Z ∟4cm).*
8. State Coulomb's law of force between any two point charges and indicate the units of the quantities involved.
9. A uniform line charge ρ_l = 25nC/m lies on the line x= -3 m, Z= 4m m, in free space. Find the electric field intensity at a point (2, 15, 3) m.
10. State and explain Gauss law. Given that $\check{D} = \frac{\rho^2 Z^2}{3} \cos\varphi \hat{a}_\varphi$, determine the flux crossing $\varphi = \frac{\pi}{4}$ half plane defined by 0≤ρ≤3 and 2≤Z≤4.
11. Derive continuity equation of current in both integral and different form.
12. Obtain Lap lace's and Poisson's equation from Gauss law.
13. With neat diagram, derive the relation between tangential and normal component of electric field at the boundary between two different dielectrics.
14. State and prove Stokes Theorem

4. State the Uniqueness theorem. – L1
5. State the Biot– Sarvart's law and Amperes circuital law. – L1
6. Analyze the Laplace's and Poison's equations with examples. – L4
7. Analyze the magnetic field intensity for different cases. – L4
8. Explain the curl and magnetic flux density. – L2
9. Discuss the Stoke's theorem as well as scalar and vector magnetic potentials. – L2
10. Solve the numerical problems on potential, energy density, magnetic field intensity, curl, magnetic flux density, scalar and vector potential. – L3

After learning all the topics of UNIT–III, the student is able to

1. Analyze the force on a moving charge, differential current element and force between differential current elements. – L4
2. Develop the expression for the torque on closed circuit. – L5
3. Explain the magnetization and permeability of magnetic material. – L2
4. Discuss the boundary condition between two magnetic materials. – L2
5. Define the self inductance and mutual inductance. – L1
6. Develop the expression for inductance of solenoid, toroid, co–axial cable, two wire transmission lines. – L5
7. Discuss the displacement current density. – L2
8. Explain the concept of retarded potential. – L2
9. Solve the numerical problems on all above topics. – L3
10. Explain the Faraday's law of electromagnetic induction. – L1

After learning all the topics of UNIT – IV, the student is able to

1. Develop the equation for uniform plane wave starting from Maxwell's equation in free space and die electric. – L5
2. State the Pointing vector. – L1
3. Explain the wave propagation in good conductor and wave polarization. – L2
4. Explain the reflection of uniform plain wave at normal incidence. – L2
5. Develop the expressions for reflection co–efficient, transmission co–efficient. – L5
6. Describe the standing waves, standing wave ratio and relationship for SWR in terms of reflection co – efficient. – L2
7. Solve the numerical problems on Pointing vector, reflecting co–efficient, transmission co–efficient, SWR. – L3
8. Develop the equation for radiation intensity, beam efficiency, directivity, gain, radiation pattern, beam area, antenna aperture, effective height and bandwidth. – L1
9. Analyze the transmission equation for radio communication links. – L4
10. Explain the antenna field zones and shape impedance considerations. – L2

After learning all the topics of UNIT – V, the student is able to

1. Analyze the field due to alternating current element hertzian dipole. – L4
2. Describe the plane earth reflection, space wave and surface wave, transition between surface and space waves. – L1
3. Explain the tilt of Wave Front due to Ground Losses, Impact of Imperfect Earth, Reduction Factor and numerical distance, earth's behavior at different Frequencies, electrical properties of the earth, curved earth reflection. – L2

Course Code : P13EC33	Semester : III	L - T - P : 4 - 0 - 0
Course Title : DIGITAL CIRCUITS DESIGN		
Contact Period: Lecture: 52 Hr, Exam: 3 Hr	**Weightage:CIE:50% SEE:50%**	

Prerequisite course for :

1. Microprocessor and Microcontroller –P13EC45
2. Digital CMOS VLSI Design – P13EC52
3. Digital design using Verilog HDL–P13EC65
4. Advanced Microcontrollers–P13EC71
5. Embedded and real time Systems–P13EC73

Course Learning Objectives (CLOs)

This course aims to

1. Explain the concept of logic families like DTL, TTL and ECL.
2. Differntiate between NMOS, PMOS and CMOS logics.
3. Explain the following concepts for designing a logic circuit: Boolean algebra, K–map, SOP and POS equations.
4. Use the knowledge of minterms, maxterms, QM method and VEM technique.
5. Differentiate between the encoders and decoders.
6. Design and implement the encoders, decoders, MUX, DEMUX, arithmetic circuit, comparators.
7. Provide the understanding of timing diagram and internal structure of various flip –flops (RS, JK, D and T).
8. Expalin the master-slave SR and master-slave JK flip flops.
9. Design and implement the sequential circuits like registers and counters.
10. Design and analyze the synchronous sequential circuit.

Course Content

UNIT – I

Classification of Integrated Circuits–I: Gate performance considerations, Diode transistor logic (DTL), Transistor– Transistor logic(TTL), Emitter Coupled Logic(ECL), MOS field –effect Transistor , NMOS and PMOS logic ,CMOS logic.

Text 2: A.5, A.6, A.7, A.8, A.9, A.10, A.11 **10 Hrs**

UNIT – II

Principles of combinational logic–I: Definition of combinational logic, Canonical forms,

Generation of switching equations from truth tables, Karnaugh maps–3, 4 and 5 variables, incompletely specified functions (Don't Care terms), Simplifying Max term equations.

Principles of combinational Logic–II: Quine – McCluskey minimization technique– Quine–McCluskey using don't care terms, Reduced Prime Implicant Tables, Map entered variables.

Text 1: 3.1 to 3.6 **11 Hrs**

UNIT – III

Analysis and design of combinational logic–I: General approach, Decoders–BCD decoders, Encoders.

Analysis and design of combinational logic–II: Digital multiplexers–Using multiplexers as Boolean function generators. Adders and subtractors – Cascading full adders, Look ahead carry, Binary comparators.

Text 1: 4.1, 4.3 to 4.5, 4.6 – 4.6.1, 4.6.2, 4.7 **11 Hrs**

UNIT – IV

Sequential Circuits–I: Basic Bi–stable Element, Latches, SR Latch, Application of SR Latch, A Switch De–bouncer, The SR Latch, The gated SR Latch, The gated D Latch, The Master–Slave Flip–Flops (Pulse–Triggered Flip–Flops): The Master–Slave SR Flip–Flops, The Master–Slave JK Flip–Flop, Edge Triggered Flip–Flop: The Positive Edge–Triggered D Flip–Flop, Negative–Edge Triggered D Flip–Flop.

Text 2: 6.1, 6.2, 6.4, 6.5 **10 Hrs**

UNIT – V

Sequential Circuits–II: Characteristic Equations, Registers, Counters – Binary Ripple Counters, Synchronous Binary counters, Counters based on Shift Registers, Design of a Synchronous counters, Design of a Synchronous Mod–6 Counter using clocked JK Flip–Flops, Design of a Synchronous Mod–6 Counter using clocked D, T, or SR Flip–Flops.

Sequential Design–I: Introduction, Mealy and Moore Models, State Machine Notation, Synchronous Sequential Circuit Analysis.

Text 2: 6.6, 6.7, 6.8, 6.9 – 6.9.1 and 6.9.2, Text 1: 6.1 to 6.3 **10 Hrs**

TEXT BOOKS:

1. "Digital Logic Applications and Design", John M Yarbrough, Thomson Learning, 2001.
2. "Digital Principles and Design", Donald D Givone, Tata McGraw Hill, 2002.

REFERENCE BOOKS:

1. "Fundamentals of logic design", Charles H Roth, Jr, Thomson Learning, 2004.
2. "Logic and computer design Fundamentals", Mono and Kim, Pearson, Second edition, 2001.
3. "Digital Design", M. Morris Mano & Michael D. Cillvette, Pearson, 5th edition, 2013.
4. "Introduction to Digital System", Milos Ercegovac, Tomas Lang, Jaime H Moreno, John Wiley, 2005.

Course Outcomes

After learning all the units of the course, the student is able to

1. Compare the performance characteristics like speed, power dissipation, noise margin and Propagation delay. – L4 (Unit – I)
2. Design the logic circuit using K–map and VEM technique. – L5 (Unit – II)
3. Design the logic circuit using digital devices for applications like decoders, encoders, Multiplexers involving combinational logic. – L5 (Unit– II)
4. Apply the knowledge of Boolean algebra to design digital systems like comparators, code convertors. – L3 (Unit – III)
5. Design the basic blocks like SR, JK, D&T flip–flops using sequential logic. – L5 (Unit – IV)
6. Design the synchronous and asynchronous counters like decade, binary, MOD –N counters using D, T and JK flip–flop. – L5 (Unit – V)

TEXT BOOKS:

1. "Engineering Electromagnetics", William H. Hayt Jr. and John A. Buck, Tata McGraw–Hill, 7th edition, 2006.
2. "Antennas and Wave Propagation", John D Kraus, Ronald J Marhefka and Ahmed S Khan, Tata McGraw Hill, 4th Edition, 2011

REFERENCE BOOKS:

1. "Electromagnetics with Application", John Kraus and Daniel .A. Fleischer, McGraw Hill,5th edition 1999.
2. "Antennas for all applications" by John D Kraus, Ronald J Marheka, Ahmad S Khan, 3rd edition, T.M.H 2006
3. "Antennas and Wave Propagation" by Harish and Sachidananda, Oxford higher education, 2008.
4. "Antennas and wave propagation", G S N Raju, Pearson Education 2005.

Course Outcomes

After learning all the units of the course, the student is able to

1. Analyze the static electric field using coulomb's law, Gauss law, Laplace's and poison's equations.– L4 (Unit – I)
2. Compute the static electric field intensity and potential due to different charge distributions. – L3 (Unit – I)
3. Analyze the steady magnetic field using Biot – Savart's law, Ampere's law and Stoke's theorem. – L4 (Unit–II)
4. Compute the force between differential current element and inductances. – L3 (Unit – III)
5. Explain the properties of TEM waves in free space, conductors and dielectric medium.– L2 (Unit – IV)
6. Explain the ground wave, space wave and sky wave propagations. – L2 (Unit – V)

Topic Learning Outcomes

After learning all the topics of UNIT – I, the student is able to

1. Define the coulomb's law and electric field intensity. – L1
2. Solve the problems on force and electrical field intensity. – L3
3. Define the electric flux density. – L1
4. Explain the Gauss law. – L2
5. Solve the numerical problems on flux density. – L3
6. Discuss the electric field intensity due to line charge. – L2
7. Explain the sheet charge and continuous volume charge. – L2
8. Explain the divergence and divergence theorem. – L2
9. Discuss the applications of Gauss law. – L2
10. Solve the numerical problems on Gauss and divergence theorems. – L3

After learning all the topics of UNIT – II, the student is able to

1. Define the potential difference of point charge and system of charges. – L1
2. Discuss the potential gradient as well as the relationship between field intensity and potential. – L2
3. Analyze the electric field and potential due to dipole and energy density in electric field. – L4

UNIT – III

Magnetic Forces, Materials and Inductance: Force on a moving charge and differential current element, force between differential current element, force and torque on closed circuit, magnetization and permeability, magnetic boundary conditions, potential energy and forces on magnetic materials, self inductance and mutual inductance

Time–Varying Fields and Maxwell's Equations: Faraday's law, displacement current, Maxwell's equations in point and integral form, retarded potentials.

Text 1:9.1 to 9.10, 10.1 to 10.5 **10 Hrs**

UNIT – IV

The Uniform Plane Wave: Uniform plane wave, Wave propagation in free space and dielectrics, Poynting vector and power considerations, propagation in good conductors (skin effect), Wave polarization

Plane Wave Reflection and Dispersion: Reflection of uniform plane waves at normal incidence, SWR, Wave Reflection from Multiple Interfaces, Plane wave Propagation in general directions.

Antenna Basics : Basic Antenna parameters, patterns, beam area, radiation intensity, beam efficiency, diversity and gain, Directivity and resolution, antenna apertures, effective height, bandwidth, the radio communication links, Fields from Oscillating Dipole, antenna field zones, Shape–Impedance considerations

Text 1: 12.1 to 12.5, 13.1, to 13.4 **11 Hrs**

UNIT–V

Radiation: Introduction, Basic Maxwell's Equation, Retarded (Time Varying) Potential, Far Field Due to an Alternating Current Element(Oscillating Dipole), Electrostatic Field, Induction Field, Hertzian Dipole, Power Radiated by a Current Element, Far Field due to Sinusoidal Current Distribution, Near Far Field due to Sinusoidal Current Distribution.

Ground Wave Propagation: Introduction, Plane Earth Reflection, Space Wave and Surface Wave, Transition Between Surface and Space Wave, Tilt of Wave Front due to Ground Losses, Impact of Imperfect Earth, Reduction Factor and Numerical Distance, Earth's Behavior at Different Frequencies, Electrical Properties of the Earth, Curved Earth Reflection.

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, Absorption by Atmospheric Phenomena, Variation of Field Strength with Height, Super Refraction, Meteorological Conditions Predicting Super Refraction, Scattering Phenomena, Tropospheric Propagation, Fading, Path Loss Calculations.

Sky Wave Propagation: Introduction, Structural Details of the Ionosphere, Wave Propagation Mechanism, Refraction in The Absence of Earth's Magnetic Field, Refraction in the Presence of the Earth's Magnetic Field, 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, Impact of Solar Activity, Multi – Hop Propagation, Take –Off Angle, Energy Loss in Ionosphere and Sky Wave Signal Strenght, Primary and Secondary Services, Wave Characteristics, VLF Wave Propagation, VHF(metric) Waves, UHF (decimetric) and SHF (centimetric) Waves, EHF (millimetric) Waves, Sub – Millimetric and Optical Waves.

Text 2: 2.1 to 2.16, 4.1 to 4.7, 23.1 to 23.10, 24.1 to 24.14, 25.1 to 25.12 **11 Hrs**

<u>Topic Learning Outcomes</u>

After learning all the topics of UNIT – I, the student is able to

1. Compare the different transistor logic families. – L4
2. Describe the DTL, TTL, and ECL. – L1
3. List the advantages of DTL, TTL, and ECL. – L1
4. Explain the limitations of DTL, TTL, and ECL. – L2
5. Analyze the characteristics of MOSFET. – L4
6. Explain the operation of nMOS and pMOS logics. – L2
7. Define the parameters of gate performance. – L1
8. Compare the performance of different logic families. – L4
9. Explain the operation of CMOS logic. – L2
10. Write the circuit diagrams for NAND, NOR and Inverter using CMOS. – L3

After learning all the topics of UNIT – II, the student is able to

1. Describe the combinational logic circuits. – L1
2. Explain the concept of canonical forms and switching equations from truth tables. – L2
3. Convert the given Boolean equation into proper canonical form. – L2
4. Solve the problems on Karnaugh maps for different variables. – L3
5. Solve the problems on Karnaugh maps including don't care terms. – L3
6. Identify the implicants, prime-implicants and essential prime-implicants on Karnaugh maps. – L2
7. Explain the concept of minterm and maxterm expressions. – L2
8. Solve the problems on Quine – McCluskey technique including don't care terms. – L3
9. Solve the problems using MEV technique. – L3
10. Predict the prime implicants using suitable techniques. – L2

After learning all the topics of UNIT – III, the student is able to

1. Explain the general design approach of combinational logic. – L2
2. Analyze the general encoder and decoder circuits. – L4
3. Design the BCD decoders. – L5
4. Write the logic diagram of priority encoder. – L3
5. Analyze the digital multiplexers. – L4
6. Design the arithmetic circuits using multiplexers. – L5
7. Analyze the cascading full adders and subtractors. – L4
8. Describe the 1–bit, 2–bit and 4–bit comparators. – L2
9. Explain the carry-look-ahead adder. – L2
10. Differentiate between decoder and encoder. – L4

After learning all the topics of UNIT – IV, the student is able to

1. Differentiate between combinational and sequential circuits. – L4
2. Explain the basic bi–stable elements such as latches. – L2
3. Discuss the applications of latches. – L2
4. Differentiate between pulse triggered and edge triggered flip–flops. – L4
5. Discuss the truth tables of D, T, SR and JK flip–flops. – L2
6. Explain the operation of Master-Slave SR flip-flop. – L2
7. Discuss the race-around condition. – L2
8. Explain the operation of Master-Slave JK flip-flop. – L2

9. Explain the operations of negative and positive edge-triggered D flip-flop. – L2
10. Differentiate between latches and flip-flops. – L4

After learning all the topics of UNIT – V, the student is able to
1. Write the characteristics equations for D, T, SR and JK flip–flops. – L3
2. Design the synchronous MOD–6 counters using JK flip–flops. – L5
3. Design the synchronous MOD–6 counters using D, T and SR flip–flops. – L5
4. Analyze the self correcting counters. – L4
5. Illustrate the concept of state machine notation. – L3
6. State the difference between Mealy and Moore models. – L1
7. Analyze the synchronous sequential circuit. – L4
8. Explain the various kinds of shift register circuits. – L2
9. Explain the operation of a ripple counter. – L2
10. Differentiate between synchronous and asynchronous sequential circuits. – L4

<u>Review Questions</u>

1. Compare the different transistor logic families used in digital IC.
2. Describe the DTL, TTL, and ECL with the help of circuit diagrams.
3. List the advantages of DTL, TTL, and ECL.
4. Explain the limitations of DTL, TTL, and ECL.
5. Explain the various characteristics associated with MOSFET.
6. Explain the operation of nMOS and pMOS logic circuits with examples.
7. Explain the various parameters of gate performance.
8. Compare the performance of different logic families with their circuits.
9. Explain the operation of CMOS logic with an example.
10. Write the circuit diagrams for NAND, NOR and Inverter using CMOS.
11. Define the combinational logic circuit and explain with an example.
12. Explain the steps to convert the given equation into canonical form.
13. Convert the following booleans equation into proper canonical form S = ab' + a'c + bcd' and R = (w + z') . (x' + y) . (w' + x + y)
14. Simplify P = ∑ (2, 3, 4, 10, 13, 14, 15) using Karnaugh maps and realize using NAND gates.
15. Simplify P = ∑ (7, 9, 11, 12, 13, 14) + ∑ d (3, 5, 6, 15) using Karnaugh maps and realize using NAND gates.
16. Identify the implicants, prime-implicants and essential prime-implicants on Karnaugh maps for the function Y = ∑ (0, 1, 2, 6, 7, 10, 12) + ∑ d (3, 5).
17. Simplify P = π (0, 2, 4, 6, 8, 12, 14, 15, 16, 18, 20, 22, 30, 31) using Karnaugh maps and realize using NOR gates.
18. Simplify Z = ∑ (1, 3, 6, 8, 9, 10, 12, 14) + ∑ d (7, 13) using Quine – McCluskey technique.
19. Simplify Q = ∑ (0, 3, 4, 11, 13) + ∑ d (2, 6, 8, 9, 10) using MEV technique.
20. Identify the prime implicants using Quine – McCluskey technique for F (W, X, Y, Z) = ∑ (1, 3, 13, 15) + ∑ d (8, 9, 10, 11).
21. With the help of block diagram, explain the general design approach of combinational logic.
22. Design a 3 : 8 decoder circuit.
23. Draw the logic diagram of BCD decoder and explain briefly.
24. Write the logic diagram and truth table of priority encoder.
25. Define multiplexer? With logic diagram explain the operation of 16 : 1 multiplexer.

Course Code : P13EC46	**Semester : IV**	**L - T - P : 3 - 0 - 0**
Course Title : ELECTROMAGNETICS AND ANTENNAS		
Contact Period: Lecture: 52 Hr, Exam: 3 Hr	**Weightage:CIE:50% SEE:50%**	

Prerequisite course for :
1. Optical Communication Systems – P13EC56
2. Microwave Devices and Integrated Circuits – P13EC63
3. GSM Communication and Networks – P13EC74
4. Satellite Communication – P13EC81

<u>Course Learning Objectives (CLOs)</u>

This course aims to
1. Provide the basic knowledge of electromagnetic waves and antennas of radio communication.
2. Describe the basic laws, properties and equations of static electric field using 3–dimensional vector method.
3. Describe the basic laws, properties and equations of static magnetic field using 3 – dimensional vector method.
4. Explain the Poisson's and Laplace's equations.
5. Analyze the concepts of magnetic forces, materials and inductance.
6. Extend the Maxwell's equations to time varying electromagnetic waves.
7. Define properties of electromagnetic waves.
8. Explain the Plane Wave Reflection and Dispersion.
9. Provide the basic knowledge of antennas and its radiation properties.
10. Give the concepts of electromagnetic wave propagation from transmitter to receiver.

<u>Course Content</u>

UNIT–I

Coulomb's Law and Eletric Field Intensity: Experimental law of Coulomb, Electric field intensity, field due to continuous volume charge, line charge and sheet charge,
Electric Flux Density, Gauss's Law and Divergence: Electric flux density, Gauss law, application of Gauss Law, Divergence and divergence theorem
Text 1: 2.1 to 2.5, 3.1, 3.2, 3.3, 3.5, 3.6, 3.7 **10 Hrs**

UNIT–II

Energy and Potential: Energy expended in moving a point charge in an electric field, line integral, definition of potential difference and potential, potential field of point charge and a system of charges, potential gradient, Dipole, energy density in an electric field,
Poisson's and Laplace's Equations: Poisson's and Laplace's equations, Uniqueness Theorem, examples of the solutions of Laplace's and Poisson's equations
The Steady Magnetic Field: Biot– Savart law, Ampere's circuital law, Curl, Stokes theorem, magnetic flux and flux density, scalar and vector magnetic potentials.
Text 1: 4.1 to 4.8, 7.1 to 7.4, 8.1 to 8.6 **10 Hrs**

Course Assessment Matrix (CAM)

Course Outcome (CO)		Program Outcome (ABET/NBA-(3a-k))										
		a	b	c	d	e	f	g	h	i	j	k
Describe the architecture, addressing modes and instruction set of 8 bit/16 bit micro processors. (Unit – I)	L1	3	1	-	-	-	-	-	-	-	-	-
Discuss the concepts of interfacing of an16 bit processor with memory and I/0. (Unit – II)	L2	3	2	-	-	-	-	-	-	-	-	-
Give the examples of various addressing modes and instruction sets of 8051. (Unit – III)	L2	2	2	-	-	-	-	-	-	-	-	-
Write the assembly language programme using the instructions ANL, ORL, XRL and CLR. (Unit – IV)	L3	3	2	2	-	1	-	-	-	-	-	-
Solve the interfacing problems on Keyboard, Display, D/A and A/D converters. (Unit – V)	L3	3	2	2	-	3	-	-	-	-	-	-
Interpret mode 0, mode 1, mode 2 and mode 3 types of serial data communication with 8051. (Unit – V)	L3	3	1	-	-	-	-	-	-	-	-	-

1 – Low, 2 – Moderate and 3 – High

26. Design the full adder circuit using multiplexer.
27. Explain the operation of a serial adder with logic diagram.
28. Design a 2–bit comparator using basic gates.
29. Explain with the logic diagram and equations the operation of carry-look-ahead adder.
30. Differentiate between the decoder and encoder circuits.
31. List the differences between the combinational and sequential circuits.
32. Explain the operation of a basic bi-stable element.
33. Explain the application of SR Latch in switch de-bouncing circuit.
34. Differentiate between the pulse triggered and edge triggered flip–flops.
35. Draw the logic diagram and truth tables of D, T, SR and JK flip–flops.
36. Explain the operation of Master-Slave SR flip-flop with neat block diagram.
37. What is the race-around condition and how to overcome the same?
38. With neat block diagram, truth table and waveforms, explain the operation of Master-Slave JK flip-flop.
39. Discuss the operations of negative and positive edge-triggered D flip-flop.
40. Differentiate between latches and flip-flops.
41. Write the characteristics equations for D, T, SR and JK flip–flops.
42. Design the synchronous MOD–6 counters using JK flip–flops.
43. Design the synchronous MOD–6 counters using D, T and SR flip–flops.
44. Write a note on the self correcting counters.
45. Explain the concept of state machine notation with an example.
46. List the difference between Mealy and Moore models.
47. Explain the steps to analyze the synchronous sequential circuit.
48. Explain the SISO, SIPO, PIPO and PISO shift register circuits.
49. Explain the operation of a 3–bit ripple counter.
50. Differentiate between synchronous and asynchronous sequential circuits.

Lesson Plan

UNIT – I

1. Classification of Integrated Circuits–I: Introduction
2. Gate performance considerations
3. Diode transistor logic (DTL)
4. Transistor– Transistor logic (TTL)
5. Emitter Coupled Logic (ECL)
6. MOS field –effect Transistor
7. NMOS logic
8. PMOS logic
9. CMOS logic
10. Differentiate NMOS, PMOS and CMOS logic gates

UNIT – II

11. Principles of combinational logic–I: Definition of combinational logic,
12. Canonical forms
13. Generation of switching equations from truth tables
14. Karnaugh maps–3, 4 and 5 variables
15. Incompletely specified functions (Don’t Care terms)
16. Simplifying Max term equations

17. Principles of combinational Logic–II: Quine – McCluskey minimization tehnique introduction
18. Quine–McCluskey using don't care terms
19. Reduced Prime Implicant Tables
20. Map entered variables
21. Test - 1

UNIT – III

22. Analysis and design of combinational logic–I: General approach
23. Decoders–BCD decoders
24. Encoders
25. Analysis and design of combinational logic–II: Digital multiplexers
26. Using multiplexers as Boolean function generators
27. Adders
28. Subtractors
29. Cascading full adders
30. Look ahead carry
31. Binary comparators

UNIT – IV

32. Sequential Circuits–I: Basic Bi–stable Element
33. Latches, SR Latch, Application of SR Latch
34. A Switch De–bouncer
35. The SR Latch, The gated SR Latch and the gated D Latch,
36. The Master–Slave Flip–Flops (Pulse–Triggered Flip–Flops): Introduction
37. The Master–Slave SR Flip–Flops
38. The Master–Slave JK Flip–Flop
39. Edge Triggered Flip–Flop: Introduction
40. The Positive Edge–Triggered D Flip–Flop
41. Negative–Edge Triggered D Flip–Flop
42. Test - 2

UNIT – V

43. Sequential Circuits–II: Characteristic Equations and Registers
44. Counters – Binary Ripple Counters
45. Synchronous Binary counters and counters based on Shift Registers
46. Design of a Synchronous counters
47. Design of a Synchronous Mod–6 Counter using clocked JK flip–flops
48. Design of a Synchronous Mod–6 Counter using clocked D, T, and SR flip–flops
49. Sequential Design–I: Introduction
50. Mealy and Moore Models
51. State Machine Notation
52. Synchronous Sequential Circuit Analysis

Course Articulation Matrix (CAM)

Course Outcome (CO)		Program Outcome (ABET/NBA-(3a-k))										
		a	b	c	d	e	f	g	h	i	j	k
Describe the architecture, addressing modes and instruction set of 8 bit/16 bit micro processors. (Unit – I)	L1	H	L	-	-	-	-	-	-	-	-	-
Discuss the concepts of interfacing of an16 bit processor with memory and I/0. (Unit – II)	L2	H	M	-	-	-	-	-	-	-	-	-
Give the examples of various addressing modes and instruction sets of 8051. (Unit – III)	L2	M	M	-	-	-	-	-	-	-	-	-
Write the assembly language programme using the instructions ANL, ORL, XRL and CLR. (Unit – IV)	L3	H	M	M	-	L	-	-	-	-	-	-
Solve the interfacing problems on Keyboard, Display, D/A and A/D converters. (Unit – V)	L3	H	M	M	-	H	-	-	-	-	-	-
Interpret mode 0, mode 1, mode 2 and mode 3 types of serial data communication with 8051. (Unit – V)	L3	H	L	-	-	-	-	-	-	-	-	-
L- Low, M- Moderate, H-High												

9. Logical and Shift and Rotate instructions
10. Illustration of these instructions with examples and related programs

UNIT – II

11. Arithmetic and Logic Instructions: Introduction, Addition and Subtraction
12. Comparison, Multiplication and Division
13. BCD and ASCII Arithmetic
14. Basic Logic Instruction, Shift and rotate
15. String Comparison and Programming Examples
16. 80386 and 80486 Processors: Introduction to the 80386 microprocessor
17. Special 80386 registers and 80386 Memory Management
18. Introduction to the 80486 Microprocessor
19. Introduction to the Pentium Microprocessor
20. Special Pentium Registers and Pentium Memory Management
21. Test - I

UNIT – III

22. The 8051 Architecture: Introduction
23. 8051 Microcontroller Hardware and Input / output pins
24. Ports and Circuits External Memory
25. Counters and timers
26. Serial data input / output, interrupts
27. Moving Data: Addressing modes
28. External data Moves
29. Code memory Read only data Moves
30. PUSH and POP Opcodes
31. Data exchanges and Example Programs

UNIT – IV

32. Logical operations: Byte level logical Operations
33. Bit Level logical Operations and Rotate and Swap operations
34. Example Programs
35. Arithmetic Operations: flags
36. Incrementing and Decrementing
37. Addition, Subtraction and Multiplication and division
38. Decimal Arithmetic and Example Programs
39. Jump and call instructions: Jump and call Program Range,
40. Jumps, Calls and Subroutines, Interrupts and Returns,
41. More Detail on Interrupts, Example Programs.
42. Test -II

UNIT – V

43. Applications: Introductions
44. Keyboard concept
45. Display concept
46. Pulse Measurements
47. D/A and A/D conversions
48. Multiple Interrupts
49. Serial Data Communications: Introduction
50. Network Configurations
51. 8051 Data Communication Modes Example Programs
52. 8051 Data Communication Modes Example Programs (continued)

Course Articulation Matrix (CAM)

Course Outcome (CO)		Program Outcome (ABET/NBA-(3a-k))										
		a	b	c	d	e	f	g	h	i	j	k
Compare the performance characteristics like speed, power dissipation, noise margin and Propagation delay. (Unit – I)	L4	M	M	-	-	-	-	-	-	-	-	-
Design the logic circuit using K–map and VEM technique. (Unit – II)	L5	H	M	H	-	M	-	-	-	-	-	-
Design the logic circuit using digital devices for applications like decoders, encoders, Multiplexers involving combinational logic. (Unit– II)	L5	H	H	M	-	M	-	-	-	-	-	-
Apply the knowledge of Boolean algebra to design digital systems like comparators, code convertors. (Unit – III)	L3	M	M	M	-	-	-	-	-	-	-	-
Design the basic blocks like SR, JK, D&T flip–flops using sequential logic. (Unit – IV)	L5	H	H	H	-	M	-	-	-	-	-	-
Design the synchronous and asynchronous counters like decade, binary, MOD –N counters using D, T and JK flip–flop . (Unit – V)	L5	H	H	M	-	M	-	-	-	-	-	-

L- Low, M- Moderate, H-High

Course Assessment Matrix (CAM)

Course Outcome (CO)		Program Outcome (ABET/NBA-(3a-k))										
		a	**b**	**c**	**d**	**e**	**f**	**g**	**h**	**i**	**j**	**k**
Compare the performance characteristics like speed, power dissipation, noise margin and Propagation delay. (Unit – I)	L4	**2**	**2**	**-**	**-**	**-**	-	-	-	-	-	-
Design the logic circuit using K–map and VEM technique. (Unit – II)	L5	**3**	**2**	**3**	**-**	**2**	-	-	-	-	-	-
Design the logic circuit using digital devices for applications like decoders, encoders, Multiplexers involving combinational logic. (Unit– II)	L5	**3**	**3**	**2**	**-**	**2**	-	-	-	-	-	-
Apply the knowledge of Boolean algebra to design digital systems like comparators, code convertors. (Unit – III)	L3	**2**	**2**	**2**	**-**	**-**	-	-	-	-	-	-
Design the basic blocks like SR, JK, D&T flip–flops using sequential logic. (Unit – IV)	L5	**3**	**3**	**3**	**-**	**2**	-	-	-	-	-	-
Design the synchronous and asynchronous counters like decade, binary, MOD –N counters using D, T and JK flip–flop . (Unit – V)	L5	**3**	**3**	**2**	**-**	**2**	-	-	-	-	-	-

1 – Low, 2 – Moderate and 3 – High

21. Describe the roles of internal ROM and RAM, I/O ports, timers and counters in the architecture of 8051 microcontroller.
22. Describe the external memory organization of 8051 microcontroller.
23. Write the structure of port 0 of 8051 microcontroller.
24. Explain the TCON, TMOD, SCON and PCON registers.
25. Explain the interrupt structure in 8051 microcontroller.
26. Describe the register, direct, indirect addressing modes of 8051 with examples.
27. Explain the concept of external addressing using MOVX and MOVC with block diagram.
28. Discuss the stack operation in 8051 with examples.
29. Write the assembly language programme to exchange a block of data in 8051 microcontroller.
30. Write the assembly language programme to transfer a block of data in reverse order.
31. Distinguish between the RLC and RRC instructions.
32. List all the special function registers of 8051 microcontroller.
33. Relate the rotate instruction with swap instruction.
34. Illustrate the use of DPTR with an example.
35. Explain the different flags used in 8051 microcontroller with suitable instructions.
36. Evaluate the sum and difference of two signed and unsigned numbers.
37. Differentiate between the incrementing and decrementing operations.
38. Differentiate between the unconditional jumps and call instructions.
39. Explain the roles of stack and stack pointers while handling subroutines.
40. Describe the sequence of events that follows while handling interrupts.
41. Develop the 8051 microcontroller – assembly language programme to interface keyboard.
42. Describe the interrupt driven programs for small keyboards.
43. Discriminate between the positive common cathode seven segment displays and common anode seven segment display.
44. Write the programs to interface intelligent LCD display to 8051 microcontroller.
45. Differentiate the timers T0 and T1 that are used to measure external frequencies.
46. Evaluate pulse width by using the timers.
47. Discuss the concepts of interfacing D/A converter to 8051 microcontroller.
48. Select the ports to interface A/D converter to 8051 microcontroller.
49. Explain the serial port configured as mode1 (the standard UART mode).
50. Discuss the use of mode3 in serial data communication.

Lesson Plan

UNIT – I

1. Introduction to Microprocessor and Computer: Historical background
2. The Microprocessor–based personal computer system
3. 8086 CPU Architecture, Machine language instructions
4. Basic 8086 configurations: Minimum mode, Maximum mode and addressing modes
5. Addressing Modes: Introduction
6. Data addressing modes and Program memory addressing modes
7. Instruction format and Data transfer and arithmetic
8. Branch type, loop, NOP & HALT and flag manipulation

After learning all the topics of UNIT –IV, the student is able to

1. Distinguish between the instructions – RLC and RRC. – L2
2. List all the special function registers of 8051. – L1
3. Relate the rotate instruction with swap instruction. – L1
4. Illustrate the use of DPTR with an example. – L3
5. Change the carry, auxiliary carry and overflow flags with suitable instructions. – L3
6. Evaluate the sum and difference of two signed and unsigned numbers. – L6
7. Identify the difference between incrementing and decrementing operations. – L4
8. Differentiate between the unconditional jumps and call instructions. – L4
9. Explain the roles of stack and stack pointers while handling subroutines. – L2
10. Describe the sequence of events that follows while handling interrupts. – L2

After learning all the topics of UNIT – V, the student is able to

1. Develop an 8051 – assembly language programme to interface keyboard. – L5
2. Judge the interrupt driven programs for small keyboards. – L6
3. Discriminate between positive common cathode seven segment displays and common anode seven segment display. – L4
4. Write the programs to interface intelligent LCD display to 8051. – L3
5. Use timers T0 and T1 to measure external frequencies. – L3
6. Evaluate pulse width by using the timers. – L6
7. Discuss the concepts of interfacing D/A converter to 8051. – L2
8. Select the ports to interface A/D converter to 8051. – L6
9. Use the serial port configured as mode1(The standard UART mode). – L3
10. Discuss the use of mode3 in serial data communication. – L2

Review Questions

1. Explain with the block diagram the architecture of 8086.
2. Write the advantages of memory segmentation.
3. Calculate the physical address using offset and effective addresses.
4. Explain the concept of program data relocation in 8086.
5. Describe the different addressing modes of 8086 with examples.
6. Discuss the machine language format for 8086 microprocessor.
7. Explain with the block diagram of minimum mode configuration of 8086.
8. Write the ALP to check whether a given number is odd or even.
9. Differentiate the PUSH and POP instructions with an example.
10. Explain LEA, LDS, XLAT, LAHF and SAHF.
11. Write the assembly language programme to perform basic Arithmetic operation.
12. List the string manipulation instruction.
13. Write the assembly language programme to perform Packed BCD to ASCII conversion.
14. Explain the instructions –DAA, DAS, AAA, AAD and AAM.
15. Write the assembly language programme to perform concatenation of string.
16. Describe the concept of 80386 memory management.
17. Write the salient features of 80486 microprocessor.
18. Explain internal structure of Pentium processor.
19. Discuss the concept of Pentium memory management.
20. Compare the 80386 and 80486 microprocessors.

Course Code : P13EC34	Semester : III	L - T - P : 4 - 0 - 0
Course Title : MEASUREMENTS AND INSTRUMENTATION		
Contact Period: Lecture: 52 Hr, Exam: 3 Hr	**Weightage:CIE:50%SEE:50%**	
Prerequisite course for : NIL		

Course Learning Objectives (CLOs)

This course aims to

1. Provide the basic knowledge of measurements and instrumentation.
2. Explain the terms in measurements – gross error, systematic error, absolute error, relative error, accuracy, precision, resolution and significant figures.
3. Design the bridge circuit for measurement of resistance, inductance and capacitance.
4. Describe the working of different bridge circuits.
5. Explain the different types of transducers like electrical transducer, strain gauges, etc.
6. Describe the operation of Differential output transducers and LVDT.
7. Provide the understanding of the working of display devices like LED, LCD, signal generators.
8. Explain the working of various signal generators.
9. Describe the analog storage oscilloscope, digital storage oscilloscope and delayed time base oscilloscope.
10. Explain the working of wave analyzers, harmonic distortion analyzer and spectrum analyzer.

Course Content

UNIT – I

Introduction: Measurement Errors: Gross errors and systematic errors, Absolute and relative errors, Accuracy, Precision, Resolution, Significant figure, Voltmeters and Multimeters: Introduction, Multi–range voltmeter, extending voltmeter ranges, Loading, AC voltmeter using Rectifiers – Half wave and full wave, Peak responding and True RMS voltmeters.

Digital Instruments: Digital Voltmeters – Introduction, DVM's based on V – T, V – F and Successive approximation principles, Resolution and sensitivity.

Text 2: 2.1 to 2.3;

Text 1: 4.1, 4.4 to 4.6, 4.12 to 4.14, 4.17, 4.18, 5.1 to 5.6, 5.9. **11 Hrs**

UNIT – II

Measurement of resistance, inductance and capacitance: Wheatstone bridge, Kelvin Bridge, AC bridges, Capacitance Comparison Bridge, Inductance comparison bridge, Maxwell's bridge, Hay's bridge, Schering's bridge, Wien's bridge, Wagner's earth connection.

Text 1: 11.1 to 11.3, 11.8, 11.9, 11.10, 11.11 11.12, 11.13 11.14, 11.15 **10 Hrs**

UNIT – III

Transducers – I: Introduction, Electrical transducers, Selecting a transducer, Resistive transducer, Resistive position transducer, Strain gauges, Resistance Thermometer, Thermistor, Inductive transducer, Differential output transducers and LVDT.

Text 1: 13.1 to 13.11 **10 Hrs**

UNIT – IV

Transducers – II: Piezoelectric transducer, Photo electric transducer, Photovoltaic transducer, Semiconductor photo diode, Photo–Transistor, Display devices LED's, LCD displays.

Signal Generators: Introduction, Fixed and variable AF oscillator, Standard signal generator Laboratory type signal generator, AF sine and Square wave generator, Function generator, Square and Pulse generator.

Text 1: 13.15 to 13.19, 2.10, 2.11, 8.1 to 8.9. **10 Hrs**

UNIT – V

Special Oscilloscopes: Delayed time–base oscilloscopes, Analog storage, Sampling and Digital storage oscilloscopes, Probes for CRO.

Wave Analyzers and Harmonic Distortion: Introduction, Basic wave analyzer, Frequency selective wave analyzer, heterodyne wave analyzer, Harmonic distortion analyzer and Spectrum analyzer.

Text 2: 10.1 to 10.4; Text 1: 7.28, 9.1 to 9.6 **11 Hrs**

TEXT BOOKS:

1. "Electronic Instrumentation", H. S. Kalsi, 3rd Edition, TMH, 2004.
2. "Electronic Instrumentation and Measurements", David A Bell, PHI/Pearson 2006.

REFERENCE BOOKS:

1. "Principles of Measurement Systems", John P. Bentley, 3rd Edition, Pearson Education, 2000.
2. "Modern Electronic Instrumentation and Measuring Techniques", Cooper D & A D Helfrick, PHI/Pearson Education, 1998.
3. "Electronic and Electrical Measurements and Instrumentation", J. B. Gupta, S. K. Kataria & Sons, Delhi.
4. "Electronics & Electrical Measurements", A K Sawhney, Dhanpat Rai & Sons, 9th edition.

Course Outcomes

After learning all the units of the course, the student is able to

1. Explain the different types of measurement errors– gross error, systematic error, absolute error, relative error. – L2 (Unit – I)
2. Differentiate between the DC and AC voltmeters. – L4 (Unit – I)
3. Design the bridge circuit for measurement of resistance, inductance and capacitance. – L5 (Unit – II)
4. Compare the different types of electrical transducers with examples. – L4 (Unit – III)
5. Explain the working of various signal generators. – L2 (Unit – IV)
6. Analyze the working of wave analyzer, harmonic distortion analyzer and spectrum analyzer. – L4 (Unit – V)

Topic Learning Outcomes

After learning all the topics of UNIT – I, the student is able to

1. Define the types of errors in measurements such as gross error, systematic error, absolute error, relative error and random error. – L1
2. Explain the terms in measurements such as accuracy, precision, resolution and significant figures. – L1

Topic Learning Outcomes

After learning all the topics of UNIT–I, the student is able to

1. Describe the roles of accumulator, stack pointer, base pointer and other 16 bit registers BX, CX, DX, DI, SI in 8086 Architecture with neat diagram. – L1
2. Outline the use of four segments – code segment, data segment, external segment and stack segment. – L4
3. Calculate the physical address using offset and effective addresses. – L4
4. Explain the concept of program data relocation in 8086. – L2
5. Describe the register, immediate, direct, register indirect addressing modes of 8086 with examples. – L2
6. Discuss the machine language format for 8086 microprocessor. – L2
7. Explain with block diagram of minimum mode configuration of 8086. – L2
8. Write the ALP to check whether a given number is odd or even. – L3
9. Differentiate PUSH and POP instruction with an example. – L4
10. Explain LEA, LDS, XLAT, LAHF and SAHF. – L2

After learning all the topics of UNIT – II, the student is able to

1. Write the assembly language programme to perform basic Arithmetic operation. – L3
2. List the string manipulation instruction. – L1
3. Write the assembly language programme to perform Packed BCD to ASCII conversion. – L2
4. Explain the instructions –DAA, DAS, AAA, AAD and AAM. – L2
5. Write an assembly language programme to perform concatenation of string. – L3
6. Describe the concept of 80386 memory management. – L1
7. Write the salient features of 80486 microprocessor. – L3
8. Explain internal structure of Pentium processor. – L2
9. Discuss the concept of Pentium memory management. – L2
10. Compare the 80386 and 80486 microprocessors. – L4

After learning all the topics of UNIT – III, the student is able to

1. Describe the roles of internal ROM and RAM, I/O ports, timers and counters in the architecture of 8051 microcontroller. – L2
2. Describe the external memory organization of 8051. – L1
3. Write the structure of port 0 of 8051. – L3
4. Explain TCON, TMOD, SCON and PCON registers. – L2
5. Explain the interrupt structure in 8051. – L2
6. Describe the register, direct, indirect addressing modes of 8051 with examples. – L2
7. Explain the concept of external addressing using MOVX and MOVC with block diagram. – L2
8. Discuss stack operation in 8051 with examples. – L2
9. Write an assembly language programme to exchange a block of data in 8051. – L3
10. Write an assembly language programme to transfer a block of data in reverse order. – L3

UNIT – IV

Logical operations: Byte level logical Operations, Bit Level logical Operations, Rotate and Swap operations, Example Programs.
Arithmetic Operations: flags , Incrementing and Decrementing , Addition , Subtraction , Multiplication and division , Decimal Arithmetic , Example Programs
Jump and call instructions: Jump and call Program Range, Jumps, Calls and Subroutines, Interrupts and Returns, More Detail on Interrupts, Example Programs.
Text 2: 6.0 – 6.4, 7.0 – 7.7, 8.0– 8.6 **10 Hrs**

UNIT – V

Applications: Introductions, Keyboard, Display, Pulse Measurements, D/A and A/D conversions, Multiple Interrupts.
Serial Data Communications: Introduction, Network Configurations, 8051 Data Communication Modes Example Programs.
Text 2: 10.0 – 10.5, 11.0 – 11.2 **10 Hrs**

TEXT BOOKS:

1. "The Intel Microprocessor, Architecture, Programming and Interfacing", Barry. B. Brey, 6th edition Pearson Education / PHI, 2003
2. "The 8051 Microcontroller: Architecture, Programming and Applications", Kenneth.J.Ayala, 2nd edition Penram International, 1996 / Thomson Learning 2005

REFERENCE BOOKS:

1. "Microcontrollers", Ajith pall, PHI – 2011
2. "Advanced Microprocessors", Daniel Tabak, 2nd Edition, TMH.
3. "Architecture, Programming and applications of Advanced microprocessors", Amar K. Ganguli Narosa pub.
4. "Microprocessors and microcontrollers", Krishnakanth, PHI - 2013.
5. "The 8051 Microcontroller and E mbedded Systems" – Using Assembly and C", Muhammad Ali Mazidi and Janice Gillespie Mazidi and Rollin D. McKinley, PHI 2006/ Pearson, 2006.
6. "Advanced Micrprocessor and peripherals" K.M.Bhuruchand and A.K. Ray, 3rd edition TMH.

Course Outcomes

After learning all the units of the course, the student is able to

1. Describe the architecture, addressing modes and instruction set of 8 bit/16 bit micro processors. – L1 (Unit – I)
2. Discuss the concepts of interfacing of an16 bit processor with memory and I/0. – L2 (Unit – II)
3. Give the examples of various addressing modes and instruction sets of 8051. – L2 (Unit – III)
4. Write the assembly language programme using the instructions ANL, ORL, XRL and CLR. – L3 (Unit – IV)
5. Solve the interfacing problems on Keyboard, Display, D/A and A/D converters. – L3 (Unit – V)
6. Interpret mode 0, mode 1, mode 2 and mode 3 types of serial data communication with 8051. – L3 (Unit – V)

3. Calculate the value of multiplier resistance in DC voltmeter. – L4
4. Demonstrate the loading effect by using two different sensitivity DC voltmeter. – L3
5. Calculate the value of multiplier resistance in AC voltmeter. – L4
6. Explain the peak responding voltmeter and true RMS voltmeter. – L2
7. State the advantages of a Digital Voltmeter (DVM) over an analog meter. – L1
8. Classify the Digital Voltmeter (DVM) and explain the operating principle. – L2
9. Define the sensitivity and resolution of DVM. – L1
10. What are the operating and performance characteritics of a DVM.

After learning all the topics of UNIT – II, the student is able to

1. Design the Wheatstone bridge and Kelvin's bridge. – L5
2. Draw the circuits of capacitance comparison bridge, AC Bridge and Maxwell's bridge. – L5
3. Explain the importance of Wagner's earth connection. – L2
4. Calculate the resistance, inductance, and capacitance in various bridge circuits. – L4
5. Describe the operation of the wheatstone bridge.
6. List and disscusses the principle applications of Kelvin's bridge.
7. Calculate the parallel resistance and capacitance that causes a wien bridge to null.
8. Explain the operation of Maxwell's bridge and derive the necessary equation.
9. Calcuate the unknown value of resistance in wheatstone bridge.
10. Derive the necessary equation for unbalanced wheatstone bridge.

After learning all the topics of UNIT – III, the student is able to

1. Define the parameters of electrical transducer. – L1
2. Draw and explain the circuit diagram of resistive transducers. – L3
3. Define the strain gauges and classify different types of strain gauges. – L1
4. Explain the different types of strain gauges. – L1
5. Explain the working of Linear Variable Differential Transducer (LVDT) with neat sketches. – L2
6. What are the functions of transducer.
7. List different types of transducer.
8. What is the difference between a thermocouple and a thermister.
9. List three types of temparature transducers and describe the applications of each.
10. Describe the working of resistive position transducer.

After learning all the topics of UNIT – IV, the student is able to

1. Explain the transducer such as piezoelectric, photoelectric, photovoltaic, semiconductor photo–devices, RTD thermocouple. – L2
2. List the classification of display devices. – L1
3. Describe the working of LED and LCD devices. – L1
4. Explain the standard signal generator block diagram. – L2
5. Explain with block diagram AF sine and square wave generators. – L2
6. Explain the block diagrams of function generator, square and pulse generator. – L2

7. Draw the complete block diagram and the system waveforms for the sweep frequency generator and frequency synthesizer. – L3
8. Explain a seven segment LED display.
9. Describe a modren laboratory type signal genrator.
10. List the various controls on the front panel of the pulse generator,mention their uses.

After learning all the topics of UNIT – V, the student is able to

1. Explain the block diagram of delayed time base oscilloscope and its need. – L2
2. Discuss the working of analog storage oscilloscope and analog sampling oscilloscope with their applications. – L2
3. Explain the basic operation of Digital Storage Oscilloscope (DSO) along with the relationship between sampling rate and bandwidth. – L2
4. Discuss the DSO oscilloscope modes of operations and applications. – L2
5. Explain the basic wave analyzer, frequency selective wave analyzer, and heterodyne wave analyzer. – L3
6. Describe the harmonic distortion analyzer and spectrum analyzer. – L2
7. What is the difference between a wave analyzer and a hormonic distortion analyzer.
8. State the applications of a spectrum analyzer.
9. Describe the working principle of spectrum analyzer.
10. Explain the working of heterodyne wave analyzer.

Review Questions

1. Define the following errors: gross error, systematic error, absolute error, relative error and random error.
2. Explain the terms in measurements such as accuracy, precision, resolution and significant figures with examples.
3. Calculate the value of multiplier resistance in DC voltmeter.
4. What is sample and hold circuit? Explain with neat sketches.
5. Calculate the value of multiplier resistor for a 10V RMS ac range on the voltmeter, I_{fsd}=1mA, R_m=250 ohm.
6. Explain the peak responding voltmeter and true RMS voltmeter.
7. State the advantages of a Digital Voltmeter (DVM) over an analog meter.
8. Classify the Digital Voltmeter (DVM) and explain the operating principle.
9. Define the sensitivity and resolution of DVM.
10. What are the operating and performance characteristics of a DVM.
11. Describe the operation of Kelvin's bridge.
12. Draw the circuits Maxwell's bridge and derive the necessary equations to find unknown inductance.
13. Explain the importance of Wagner's earth connection.
14. Obtain the equations to find unknown value of capacitance and dissipation factor in Schering's bridge.
15. Describe the operation of the Wheatstone bridge.
16. List and discusses the principle applications of Kelvin's bridge.
17. Calculate the parallel resistance and capacitance that causes a Wien bridge to null.
18. Explain the operation of Wien's bridge and derive the necessary equation.

Course Code : P13EC45	Semester : IV	L - T - P : 4 - 0 - 0
Course Title : MICROPROCESSOR AND MICROCONTROLLER		
Contact Period: Lecture: 52 Hr, Exam: 3 Hr		**Weightage:CIE:50% SEE:50%**

Prerequisite course for :

1. Advanced Microcontrollers – P13EC71
2. Embedded and Real time Systems – P13EC73

Course Learning Objectives (CLOs)

This course aims to

1. Describe the architecture of a 16 bit processor.
2. Explain the addressing modes and the modes of 8086 – operation.
3. Explain the arithmetic and logical instructions.
4. Describe the architecture of 80386 and 80486 processors.
5. Describe the architecture of 8051 microcontroller.
6. Expose the features of architecture of 8051 microcontroller.
7. Use the knowledge of logical instructions in 8051 microcontroller.
8. List the applications of 8051 microcontroller.
9. Describe the concepts of serial communication using 8251.
10. Provide the concept of memory and I/O interfacing.

Course Content

UNIT – I

Introduction to Microprocessor and Computer: Historical background, The Microprocessor–based personal computer system, 8086 CPU Architecture, Machine language instructions, Basic 8086 configurations: Minimum mode, Maximum mode, addressing modes

Addressing Modes: Introduction, Data addressing modes, Program memory addressing modes, Instruction format, Data transfer and arithmetic, Branch type, loop, NOP & HALT, flag manipulation, Logical and Shift and Rotate instructions, Illustration of these instructions with examples and related programs.

Text 1: 1.1 – 1.2, 2.1– 2.5, 9.6, 3.1 – 3.2, 4.1– 4.5 **11 Hrs**

UNIT – II

Arithmetic and Logic Instructions: Introduction, Addition, Subtraction, Comparison, Multiplication and Division, BCD and ASCII Arithmetic, Basic Logic Instruction, Shift and rotate, String Comparison, Programming Examples.

80386 and 80486 Processors: Introduction to the 80386 microprocessor, Special 80386 registers, 80386 Memory Management, Introduction to the 80486 Microprocessor, Introduction to the Pentium Microprocessor, Special Pentium Registers and Pentium Memory Management.

Text 1: 5.1 – 5.6, 17.1 – 17.3, 17.7, 18.1 – 18.3 **11 Hrs**

UNIT – III

The 8051 Architecture: Introduction, 8051 Microcontroller Hardware, Input / output pins, Ports and Circuits External Memory, Counters and timers, Serial data input / output, interrupts.

Moving Data: Addressing modes, External data Moves, Code memory Read only data Moves, PUSH and POP Opcodes, Data exchanges, Example Programs

<u>Course Assessment Matrix (CAM)</u>

Course Outcome (CO)		Program Outcome (ABET/NBA-(3a-k))										
		a	**b**	**c**	**d**	**e**	**f**	**g**	**h**	**i**	**j**	**k**
Explain the concept of DFT and its properties. (Unit – I)	L2	3	1	-	-	-	-	-	-	-	-	-
Describe the use of DFT in linear filtering. (Unit – I)	L2	2	1	-	-	-	-	-	-	-	-	-
Apply the fast fourier algorithm in different applications. (Unit – II)	L3	3	2	-	-		-	-	-	-	-	-
Design the IIR filters and FIR filters for given specification. (Unit – III)	L3	3	3	3	-	1	-	-	-	-	-	-
Design the IIR filters from analog filters for given specification. (Unit – IV)	L3	3	3	3	-	2	-	-	-	-	-	-
Design the discrete–time systems. (Unit – V)	L2	3	3	3	-	2	-	-	-	-	-	-

1 – Low, 2 – Moderate and 3 – High

19. Calculate the unknown value of resistance in Wheatstone bridge.
20. Derive the necessary equation for unbalanced Wheatstone bridge.
21. Define the parameters of electrical transducer.
22. Draw and explain the circuit diagram of resistive transducers.
23. Define the strain gauges and classify different types of strain gauges.
24. Explain the different types of strain gauges.
25. Explain the working of Linear Variable Differential Transducer (LVDT) with neat sketches.
26. What are the functions of transducer?
27. List different types of transducer.
28. What is the difference between a thermocouple and a thermister.
29. List three types of temperature transducers and describe the applications of each.
30. Describe the working of resistive position transducer.
31. Explain the working principle of thermocouple.
32. List the classification of display devices.
33. Describe the working of LED and LCD devices with figures.
34. Explain the standard signal generator with block diagram.
35. Explain with block diagram AF sine and square wave generators.
36. Explain with the block diagram of function generator.
37. Draw the complete block diagram and the system waveforms for the sweep frequency generator and frequency synthesizer and explain.
38. Explain a seven segment LED display.
39. Describe a modern laboratory type signal generator.
40. List the various controls on the front panel of the pulse generator, mention their uses.
41. Explain the block diagram of delayed time base oscilloscope and its need.
42. Discuss the working of analog storage oscilloscope and analog sampling oscilloscope with their applications.
43. Explain the basic operation of Digital Storage Oscilloscope (DSO) along with the relationship between sampling rate and bandwidth.
44. Discuss the DSO oscilloscope modes of operations and applications.
45. Explain the basic wave analyzer, frequency selective wave analyzer.
46. Describe the harmonic distortion analyzer
47. What is the difference between a wave analyzer and a harmonic distortion analyzer?
48. State the applications of a spectrum analyzer.
49. Describe the working principle of spectrum analyzer.
50. Explain the working of heterodyne wave analyzer.

<u>Lesson Plan</u>

UNIT – I

1. Introduction: Measurement Errors: Gross errors and systematic errors
2. Absolute and relative errors, Accuracy, Precision, Resolution, Significant figure
3. Voltmeters and multimeters: Introduction,
4. Multi–range voltmeter, extending voltmeter ranges
5. Loading, AC voltmeter using Rectifiers – Half wave and full wave
6. Peak responding and True RMS voltmeters
7. Digital Instruments: Digital Voltmeters – Introduction

8. DVM's based on V – T, V – F
9. Successive approximation principles
10. Resolution and sensitivity

UNIT – II

11. Measurement of resistance, inductance and capacitance: Wheatstone bridge
12. Kelvin Bridge
13. AC bridges
14. Capacitance Comparison Bridge
15. Inductance Comparison Bridge
16. Maxwell's bridge
17. Hay's bridge
18. Schering's bridge
19. Wien's bridge
20. Wagner's earth connection
21. Test - I

UNIT – III

22. Transducers – I: Introduction
23. Electrical transducers
24. Selecting a transducer
25. Resistive transducer
26. Resistive position transducer
27. Strain gauges
28. Resistance Thermometer
29. Thermistor
30. Inductive transducer
31. Differential output transducers and LVDT

UNIT – IV

32. Transducers – II: Piezoelectric transducer
33. Photo electric transducer and Photovoltaic transducer
34. Semiconductor photo diode
35. Photo–Transistor
36. Display devices LED's, LCD displays
37. Signal Generators: Introduction
38. Fixed and variable AF oscillator
39. Standard signal generator Laboratory type signal generator
40. AF sine and Square wave generator
41. Function generator, Square and Pulse generator
42. Test - II

UNIT – V

43. Special Oscilloscopes: Delayed time–base oscilloscopes
44. Analog storage
45. Sampling and Digital storage oscilloscopes
46. Probes for CRO
47. Wave Analyzers and Harmonic Distortion: Introduction
48. Basic wave analyzer
49. Frequency selective wave analyzer
50. Heterodyne wave analyzer
51. Harmonic distortion analyzer
52. Spectrum analyzer

Unit–V

43. Implementation of Discrete–time systems: Introduction
44. Structures for IIR systems – direct form I systems
45. Structures for FIR systems – direct form I systems
46. Structures for IIR systems – direct form II systems
47. Structures for FIR systems – direct form II systems
48. Problems on FIR and IIR systems for direct form I systems
49. Problems on FIR and IIR systems for direct form I systems
50. Cascade realization
51. Lattice realization
52. Parallel realization

Course Articulation Matrix (CAM)

Course Outcome (CO)		Program Outcome (ABET/NBA-(3a-k))										
		a	**b**	**c**	**d**	**e**	**f**	**g**	**h**	**i**	**j**	**k**
Explain the concept of DFT and its properties. (Unit – I)	L2	H	L	-	-	-	-	-	-	-	-	-
Describe the use of DFT in linear filtering. (Unit – I)	L2	M	L	-	-	-	-	-	-	-	-	-
Apply the fast fourier algorithm in different applications. (Unit – II)	L3	H	M	-	-		-	-	-	-	-	-
Design the IIR filters and FIR filters for given specification. (Unit – III)	L3	H	H	H	-	L	-	-	-	-	-	-
Design the IIR filters from analog filters for given specification. (Unit – IV)	L3	H	H	H	-	M	-	-	-	-	-	-
Design the discrete–time systems. (Unit – V)	L2	H	H	H	-	M	-	-	-	-	-	-

L- Low, M- Moderate, H-High

Lesson Plan

Unit–I

1. Discrete Fourier Transforms (DFT): Discrete Fourier Transforms
2. DFT as a linear transformation
3. Its relationship with other transforms
4. Properties of DFT– Periodicity
5. Linearity and Symmetry Properties
6. Properties of DFT
7. Multiplication of two DFTs– the circular convolution
8. Additional DFT properties
9. Use of DFT in linear filtering
10. Overlap–save and overlap–add method

Unit–II

11. Fast–Fourier–Transform (FFT) algorithms: Direct computation of DFT
12. Need for efficient computation of the DFT (FFT algorithms)
13. Goertzel algorithm
14. Chirp–z transform
15. Radix–2 FFT algorithm for the computation of DFT
16. Problems on Radix–2 FFT algorithm for the computation of DFT
17. Radix–2 FFT algorithm for the computation of IDFT–decimation in–time
18. Problems on Radix–2 FFT algorithm for the computation of IDFT–decimation in –time
19. Decimation–in –frequency algorithms
20. Applications of FFT Algorithms
21. Test - I

Unit–III

22. FIR filter design: Characteristics of commonly used analog filters
23. Butterworth filters
24. Chebyshev filters
25. Problems on Butterworth and chebyshev filters
26. Analog to analog frequency transformations
27. FIR filter design: Introduction to FIR filters
28. Design of FIR filters using – Rectangular
29. Design of FIR filters using – Hamming
30. Design of FIR filters using – Bartlet and Kaiser windows
31. FIR filter design using frequency sampling technique

Unit–IV

32. Design of IIR filters from analog filters (Butterworth and Chebyshev): Introduction
33. Impulse invariance method
34. Mapping of transfer functions
35. Approximation of derivative using backward difference method
36. Problems on derivative using backward difference method
37. Approximation of derivative using bilinear transformation method
38. Problems on derivative using bilinear transformation method
39. Matched z transforms
40. Problems on matched Z transforms
41. Verification for stability and linearity during mapping
42. Test – II

Course Articulation Matrix (CAM)

Course Outcome (CO)		Program Outcome (ABET/NBA-(3a-k))										
		a	**b**	**c**	**d**	**e**	**f**	**g**	**h**	**i**	**j**	**k**
Explain the different types of measurement errors– gross error, systematic error, absolute error, relative error. (Unit – I)	L2	H	M	L	-	-	-	-	-	-	-	-
Differentiate between the DC and AC voltmeters. (Unit – I)	L4	H	H	-	-	L	-	-	-	-	-	-
Design the bridge circuit for measurement of resistance, inductance and capacitance. (Unit – II)	L5	H	H	M	-	L	-	-	-	-	-	-
Compare the different types of electrical transducers with examples. (Unit – III)	L4	M	L	-	-	-	-	-	-	-	-	-
Explain the working of various signal generators. (Unit – IV)	L4	L	M	-	-	-	-	-	-	-	-	-
Analyze the working of wave analyzer, harmonic distortion analyzer and spectrum analyzer. (Unit – V)	L4	M	M	-	-	-	-	-	-	-	-	-

L- Low, M- Moderate, H-High

Course Assessment Matrix (CAM)												
Course Outcome (CO)		**Program Outcome** (ABET/NBA-(3a-k))										
		a	**b**	**c**	**d**	**e**	**f**	**g**	**h**	**i**	**j**	**k**
Explain the different types of measurement errors– gross error, systematic error, absolute error, relative error. (Unit – I)	L2	3	2	1	-	-	-	-	-	-	-	-
Differentiate between the DC and AC voltmeters. (Unit – I)	L4	3	3	-	-	1	-	-	-	-	-	-
Design the bridge circuit for measurement of resistance, inductance and capacitance. (Unit – II)	L5	3	3	2	-	1	-	-	-	-	-	-
Compare the different types of electrical transducers with examples. (Unit – III)	L4	2	1	-	-	-	-	-	-	-	-	-
Explain the working of various signal generators. (Unit – IV)	L4	1	2	-	-	-	-	-	-	-	-	-
Analyze the working of wave analyzer, harmonic distortion analyzer and spectrum analyzer. (Unit – V)	L4	2	2	-	-	-	-	-	-	-	-	-
1 – Low, 2 – Moderate and 3 – High												

7. Discuss the additional properties of DFT.
8. Use the DFT in linear filtering.
9. Explain the overlap–save method of DFT.
10. Explain the overlap– add method of DFT.
11. Explain the fast–fourier–transform algorithms.
12. Solve the problems on direct computation of DFT.
13. Explain the need efficient computation of the DFT.
14. Solve the problems on Goertzel algorithm.
15. State the chirp–z transforms.
16. Develop the Radix–2 FFT algorithm for the computation of DFT.
17. Develop the Radix–2 FFT algorithm for the computation of IDFT.
18. Outline the concept of decimation in–time.
19. Explain the concept of decimation–in –frequency algorithms.
20. State the applications of FFT Algorithms.
21. List the characteristics of commonly used analog filters.
22. Design the butterworth filters for given specifications.
23. Design the chebyshev filters for given specifications.
24. Explain the analog to analog frequency transformations.
25. Design the FIR filter for given specifications.
26. Design the FIR filters using – Rectangular windows.
27. Design the FIR filters using – Hamming windows.
28. Design the FIR filters using – Bartlet windows.
29. Design the FIR filters using – Kaiser windows.
30. Explain the FIR filter design using frequency sampling technique.
31. Design the IIR filters from digital Butterworth filters.
32. Design the IIR filters from digital Chebyshev filters.
33. Design the IIR filters from analog filters using impulse invariance method.
34. Explain the mapping of transfer functions.
35. Explain the approximation of derivative using backward difference bilinear method.
36. Describe the frequency transformations of various filters.
37. Explain the approximation of derivative using transformation method.
38. Explain the matched z transforms.
39. Describe the verification for stability and linearity during mapping.
40. Solve the IIR filter problems to compute the order of the filter.
41. Explain the implementation of discrete–time systems.
42. Describe the structures for IIR filters.
43. Explain the FIR systems using direct form I and direct form II systems.
44. Discuss the cascade method for IIR filter with example.
45. Explain the lattice method for FIR filter with example.
46. Explain the lattice method for IIR filter with example.
47. Describe the parallel realization method for the IIR filter with example.
48. Implement the IIR filter design using lattice structure.
49. Design the FIR filters using lattice structure.
50. Compare the IIR and FIR filters.

7. Develop the Radix–2 FFT algorithm for the computation of IDFT. – L5
8. Outline the concept of decimation in–time. – L4
9. Explain the concept of decimation–in –frequency algorithms. – L2
10. State the applications of FFT Algorithms. – L1

After learning all the topics of UNIT – III, the student is able to
1. List the characteristics of commonly used analog filters. – L1
2. Design the butterworth filters for given specifications. – L3
3. Design the chebyshev filters for given specifications. – L3
4. Explain the analog to analog frequency transformations. – L2
5. Design the FIR filter for given specifications. – L3
6. Design the FIR filters using – Rectangular windows. – L3
7. Design the FIR filters using – Hamming windows. – L3
8. Design the FIR filters using – Bartlet windows. – L3
9. Design the FIR filters using – Kaiser windows. – L3
10. Explain the FIR filter design using frequency sampling technique. – L2

After learning all the topics of UNIT – IV, the student is able to
1. Design the IIR filters from digital Butterworth filters. – L3
2. Design the IIR filters from digital Chebyshev filters. – L3
3. Design the IIR filters from analog filters using impulse invariance method. – L2
4. Explain the mapping of transfer functions. – L2
5. Explain the approximation of derivative using backward difference bilinear method. – L2
6. Describe the frequency transformations of various filters. – L2
7. Explain the approximation of derivative using transformation method. – L2
8. Explain the matched z transforms. – L2
9. Describe the verification for stability and linearity during mapping. – L1
10. Solve the IIR filter problems to compute the order of the filter. – L3

After learning all the topics of UNIT – V, the student is able to
1. Explain the implementation of discrete–time systems. – L2
2. Describe the structures for IIR filters. – L1
3. Explain the FIR systems using direct form I and direct form II systems. – L2
4. Discuss the cascade method for IIR filter with example. – L2
5. Explain the lattice method for FIR filter with example. – L2
6. Explain the lattice method for IIR filter with example. – L2
7. Describe the parallel realization method for the IIR filter with example. – L2
8. Implement the IIR filter design using lattice structure. – L2
9. Design the FIR filters using lattice structure. – L5
10. Compare the IIR and FIR filters. – L4

Review Questions

1. Explain the Discrete Fourier Transforms of signals.
2. Describe the DFT as a linear transformation.
3. Explain the DFT relationship with other transforms.
4. Discuss the Properties of DFT.
5. Solve the problems on Periodicity, linearity and Symmetry Properties.
6. Explain the multiplication of two DFTs using the circular convolution.

Course Code : P13EC35	**Semester : III**	**L - T - P : 3 - 0 - 0**
Course Title : ELECTRICAL NETWORK ANALYSIS		
Contact Period: Lecture: 52 Hr, Exam: 3 Hr	**Weightage:CIE:50% SEE:50%**	

Prerequisite course for :
1. Industrial Electronics – P13EC43
2. Digital CMOS VLSI Design – P13EC52
3. Analog CMOS VLSI Design – P13EC64

Course Learning Objectives (CLOs)

This course aims to
1. Provide the basic concepts of electrical circuit and its analysis.
2. Explain the various network terminologies, components and topologies.
3. Describe the network simplification using star and delta transformations.
4. Construct the graph for a given network of passive elements and sources.
5. Sketch the oriented graph for the given circuit of passive elements.
6. State and apply the circuit theorems for analysis.
7. Provide the understanding of networks under initial conditions of components.
8. Apply the knowledge of Laplace transforms to circuit analysis.
9. Design the resonant circuit and to describe its characteristics.
10. Analyze the circuits using two–port network parameters like Impedance (Z), Admittance (Y), Hybrid (H) and transmission parameters (A, B, C and D).

Course Content

UNIT–I

Basic Concepts: Introduction, circuit components, Definitions, source of electrical energy Kirchhoff's laws, source transformation, mesh and node analysis.
Text 1: 1.1, 1.2, 1.4, 1.6, 2.2, 2.3, 2.4 **10 Hrs**

UNIT–II

Graph Theory and Network Equation: Introduction, graph of a network, Trees, Cotres and Loops, Incidence Matrix, Cut-Set Matrix, Tie-Set Matrix and Loop Currents, Number of Possible Trees of a Graph, Analysis of Networks, Network Equilibrium Equation, Duality, General Network Transformations.
Text 1: 3.1 to 3.11 **11 Hrs**

UNIT–III

Network Theorems: Superposition theorem, Reciprocity theorem, Thevenin's theorem, Norton's theorem, Millman's theorem, Maximum power transfer theorem.
Resonance: Introduction, Series resonance, Parallel resonance.
Text 1: 7.2 to 7.7, 8.1 to 8.3 **10 Hrs**

UNIT–IV

Initial Conditions: Why study initial conditions, Initial conditions in elements, Geometrical interpretation of derivatives, Procedure to evaluate initial conditions. Initial state of a Network.
Laplace Transformation: Introduction, Laplace Transformation, some basic theorems, partial fraction expansion, the shifted unit step function, Ramp& Pulse response, convolution integral.
Text 2: 5.1 to 5.5, 7.1 to 7.3, 7.5, 8.1, 8.2, 8.5 **11 Hrs**

UNIT–V

Network Functions: Concept of complex frequency, Network functions for one & two port networks. Poles & zeros of network functions, Restrictions on pole & zero locations for driving point functions & transfer functions, Time domain behavior from pole – zero plots.

Two–Port Network Parameters: Short–Circuit admittance parameters, Open circuit impedance parameters, Transmission parameters, Hybrid parameters, Relationships between parameters.

Text 2: 9.1, 10.2, 10.4 to 10.7, 11.2 to 11.6 **10 Hrs**

TEXT BOOKS:

1. "Networks and Systems", D. Roy Choudhury, First edition, New Age International, Reprint 2005.
2. "Network Analysis", M.E .Van Valkenburg, 3rd edition, Pearson/ PHI, Reprint 2006.

REFERENCE BOOKS:

1. 'Circuits', A. Bruce Carison, Thomson Learning 2002
2. "Network Analysis", Bakshi, Technical Publications edn,2013
3. "Network Analysis and Synthesis", Chitode, Jalnekar, Edn. 2013, Technical Publications.

Course Outcomes

After learning all the units of the course, the student is able to

1. Apply the KVL and KCL to find out branch and loop currents and voltages in different parts of the circuits. – L3 (Unit – I)
2. Sketch all possible trees of the network after drawing the corresponding graph. – L3 (Unit – II)
3. Analyze the AC and DC circuits using circuit theorems like, Superposition theorem, Thevenin's theorem, Norton's theorem, Reciprocity theorem, Maximum power transfer theorem, Millman's theorem. – L4 (Unit – III)
4. Examine the performance of series and parallel resonance circuits with respect to resonant frequency, reactance curves, selectivity, bandwidth and Q – factor. – L4 (Unit – III)
5. Solve the network problems using Laplace transform. – L3 (Unit – IV)
6. Analyze the two port networks using Impedance (Z), Admittance (Y), Hybrid (H) and transmission parameters (A, B, C and D). – L4 (Unit – V)

Topic Learning Outcomes

After learning all the topics of UNIT – I, the student is able to

1. Solve the network using source transformation. – L3
2. Explain the concepts of KVL, KCL, current divider and voltage divider rules. – L2
3. Discriminate the effect of dependent and independent sources on the circuitry. – L4
4. Apply the KVL for given AC circuitry using mesh analysis. – L3
5. Apply the KVL for given DC circuitry using mesh analysis. – L3
6. Apply the KCL for given AC circuitry using nodal analysis. – L3
7. Apply the KCL for given DC circuitry using nodal analysis. – L3
8. Rearrange the electrical networks using Star/Delta transformations. – L5

Unit–IV

Design of IIR filters from analog filters (Butterworth and Chebyshev) : impulse invariance method. Mapping of transfer functions: Approximation of derivative (backward difference and bilinear transformation) method, Matched z transforms, Verification for stability and linearity during mapping

Text: 10.3.1, 10.3.2, 10.3.3 **10 Hrs**

Unit–V

Implementation of Discrete–time systems: Structures for IIR and FIR systems– direct form I and direct form II systems, cascade, lattice and parallel realization

Text: 9.1, 9.2, 9.3 **10 Hrs**

TEXT BOOK:

Digital Signal Processing – Principles Algorithms & Applications, Proakis & Monalakis, PHI / Pearson Education, 4th Edition, New Delhi,2007.

REFERENCE BOOKS:

1. Discrete Time Signal Processing, Oppenheim & Schaffer, PHI,2003.
2. Digital Signal Processing, S. K. Mitra, Tata Mc–Graw Hill, 3rd Edition, 2007.
3. Digital signal processing, Lee Tan, Elsevier publications, 2007

Course Outcomes

After learning all the units of the course, the student is able to

1. Explain the concept of DFT and its properties. – L2 (Unit – I)
2. Describe the use of DFT in linear filtering. – L2 (Unit – I)
3. Apply the fast fourier algorithm in different applications. – L3 (Unit – II)
4. Design the IIR filters and FIR filters for given specification. – L3 (Unit – III)
5. Design the IIR filters from analog filters for given specification. – L3 (Unit – IV)
6. Design the discrete–time systems – L2 (Unit – V)

Topic Learning Outcomes

After learning all the topics of UNIT – I, the student is able to

1. Explain the Discrete Fourier Transforms of signals. – L2
2. Describe the DFT as a linear transformation. – L1
3. Explain the DFT relationship with other transforms. – L2
4. Discuss the Properties of DFT. – L2
5. Solve the problems on Periodicity, linearity and Symmetry Properties. – L3
6. Explain the multiplication of two DFTs using the circular convolution. – L2
7. Discuss the additional properties of DFT. – L2
8. Use the DFT in linear filtering. – L3
9. Explain the overlap–save method of DFT. – L2
10. Explain the overlap– add method of DFT. – L2

After learning all the topics of UNIT – II, the student is able to

1. Explain the fast–fourier–transform algorithms. – L2
2. Solve the problems on direct computation of DFT. – L3
3. Explain the need efficient computation of the DFT. – L2
4. Solve the problems on Goertzel algorithm. – L3
5. State the chirp–z transforms. – L1
6. Develop the Radix–2 FFT algorithm for the computation of DFT. – L5

Course Code : P13EC44	Semester : IV	L - T - P : 4 - 0 - 0
Course Title : DIGITAL SIGNAL PROCESSING		
Contact Period: Lecture: 52 Hr, Exam: 3 Hr	**Weightage:CIE:50% SEE:50%**	

Prerequisite course for :
1. Digital Signal Processor and Applications – P13EC55
2. Digital Image Processing – P13EC61

Course Learning Objectives (CLOs)

This course aims to
1. Provide the knowledge of DFT and its various properties.
2. Provide the knowledge of the IDFT and its various properties.
3. Provide the knowledge of the single N – point DFT.
4. Provide the knowledge of DIT-FFT and DIF-FFT algorithms.
5. Provide the design procedure of IIR filters and FIR filters using different techniques.
6. Differentiate between butterworth and chebyshev filters.
7. Provide the design of IIR filters from analog filters using different methods.
8. Explain the approximations of derivative method and matched Z – transform.
9. Provide implementation scheme of IIR and FIR filters using different methods.
10. Describe the lattice structure for IIR and FIR filters.

Course Content

Unit–I

Discrete Fourier Transforms (DFT): Discrete Fourier Transforms, DFT as a linear transformation, its relationship with other transforms. Properties of DFT– Periodicity, linearity and Symmetry Properties. Properties of DFT, multiplication of two DFTs– the circular convolution, additional DFT properties, use of DFT in linear filtering, overlap–save and overlap–add method.

Text: 7.1.2, 7.1.3, 7.1.4, 7.2.1 7.2.2, 7.2.3, 7.3.1, 7.2.3 **11 Hrs**

Unit–II

Fast–Fourier–Transform (FFT) algorithms: Direct computation of DFT, need for efficient computation of the DFT (FFT algorithms), Goertzel algorithm, and chirp–z transform. Radix–2 FFT algorithm for the computation of DFT and IDFT–decimation in–time and decimation–in –frequency algorithms, applications of FFT Algorithms.

Text: 8.1, 8.1.1, 8.1.2, 8.1.3, 8.1.5, 8.1.6, 8.2, 8.3 **11 Hrs**

Unit–III

FIR filter design: Characteristics of commonly used analog filters – Butterworth and Chebyshev filters., analog to analog frequency transformations. FIR filter design: Introduction to FIR filters, design of FIR filters using – Rectangular, Hamming, Bartlet and Kaiser windows, FIR filter design using frequency sampling technique

Text: 10.2.1, 10.2.2, 10.2.3 10.3.4, 10.3.5, 10.4 **10 Hrs**

9. Solve the problems on super mesh analysis. – L3
10. Solve the problems on super nodal analysis. – L3

After learning all the topics of UNIT – II, the student is able to
1. Calculate the branch current in terms of loop current for a particular tree of a given network. – L4
2. Develop the directed graph along with a set matrix of the graph for a given network. – L5
3. Outline the properties of trees and complete incidence matrix. – L1
4. Solve the problems on trees using various matrix methods. – L3
5. Write down the network equilibrium equations for a given R–L network. – L3
6. Solve the problems on R-L network equilibrium circuits. – L3
7. Construct a dual network for the original network. – L4
8. Convert Star to Delta and Delta to Star networks. – L2
9. Solve the problems on Star to Delta conversion. – L3
10. Solve the problems on Delta to star conversion. – L3

After learning all the topics of UNIT – III, the student is able to
1. Analyze the AC and DC circuits using Superposition theorem. – L4
2. Analyze the AC and DC circuits using Thevenin's theorem and Norton's theorem. – L4
3. Analyze the AC and DC circuits using Reciprocity theorem. – L4
4. Analyze the AC and DC circuits using Maximum power transfer theorem. – L4
5. Analyze the AC and DC circuits using Millman's theorem. – L4
6. Identify the condition for the resonance. – L1
7. State the resonance frequency for series and parallel circuits. – L1
8. Design the series and parallel resonant circuits. – L5
9. Calculate the maximum frequency for series and parallel resonant circuits. – L4
10. Indicate the parameters like Selectivity, bandwidth, Q – factor for series and parallel circuits. – L2

After learning all the topics of UNIT – IV, the student is able to
1. Discuss the need for initial conditions. – L2
2. Explain the concept of initial conditions in elements. – L2
3. Examine the behaviour of elements like R, L, C under initial and steady state conditions. – L4
4. Describe the procedure to evaluate initial conditions. – L2
5. Solve the networks using initial conditions. – L3
6. Locate the roots of a polynomial. – L2
7. Solve the differential equations using the Laplace transformation method. – L3
8. Identify the impulse and pulse response of RC and RL circuits. – L2
9. Explain the ramp& pulse response. – L2
10. Describe the concept of convolution integral. – L2

After learning all the topics of UNIT – V, the student is able to
1. Explain the concept of complex frequency. – L2
2. Describe the network functions for one & two port networks. – L2
3. Locate the roots of polynomial and locus of roots. – L2
4. Identify the zeros and poles on the complex s–plane of a given two port network. – L4

5. Express the behaviour of pole – zero plots into Time domain. – L2
6. Assess the stability of given network's characteristic equation. – L6
7. Distinguish the network function for one–port and two–port networks. – L4
8. Define two-port network and its parameters. – L1
9. Relate the different parameters like Z, Y, H and T. – L4
10. Solve the problems on different parameters like Z, Y, H and T. – L3

Review Questions

1. Solve the network using source transformation.
2. Explain the concepts of KVL, KCL, current divider and voltage divider rules.
3. Discriminate the effect of dependent and independent sources on the circuitry.
4. Apply the KVL for given AC circuitry using mesh analysis.
5. Apply the KVL for given DC circuitry using mesh analysis.
6. Apply the KCL for given AC circuitry using nodal analysis.
7. Apply the KCL for given DC circuitry using nodal analysis.
8. Rearrange the electrical networks using Star/Delta transformations.
9. Solve the problems on super mesh analysis.
10. Solve the problems on super nodal analysis.
11. Calculate the branch current in terms of loop current for a particular tree of a given network.
12. Develop the directed graph along with a set matrix of the graph for a given network.
13. Outline the properties of trees and complete incidence matrix.
14. Solve the problems on trees using various matrix methods.
15. Write down the network equilibrium equations for a given R–L network.
16. Solve the problems on R-L network equilibrium circuits.
17. Construct a dual network for the original network.
18. Convert Star to Delta and Delta to Star networks.
19. Solve the problems on Star to Delta conversion.
20. Solve the problems on Delta to star conversion.
21. Analyze the AC and DC circuits using Superposition theorem.
22. Analyze the AC and DC circuits using Thevenin's theorem and Norton's theorem.
23. Analyze the AC and DC circuits using Reciprocity theorem.
24. Analyze the AC and DC circuits using Maximum power transfer theorem.
25. Analyze the AC and DC circuits using Millman's theorem.
26. Identify the condition for the resonance.
27. State the resonance frequency for series and parallel circuits.
28. Design the series and parallel resonant circuits.
29. Calculate the maximum frequency for series and parallel resonant circuits.
30. Indicate the parameters like Selectivity, bandwidth, Q – factor for series and parallel circuits.
31. Discuss the need for initial conditions.
32. Explain the concept of initial conditions in elements.
33. Examine the behaviour of elements like R, L, C under initial and steady state conditions.
34. Describe the procedure to evaluate initial conditions.
35. Solve the networks using initial conditions.
36. Locate the roots of a polynomial.

Course Assessment Matrix (CAM)

Course Outcome (CO)		Program Outcome (ABET/NBA-(3a-k))										
		a	**b**	**c**	**d**	**e**	**f**	**g**	**h**	**i**	**j**	**k**
Describe the working of semiconductor devices and its characteristics. (Unit – I)	L1	2	1	-	-	-	-	-	-	-	-	-
Discuss the different converters. (Unit – I)	L2	1	2	3	-	-	-	-	-	-	-	-
Design the AC voltage controllers with resistive and inductive load. (Unit – II)	L5	3	2	2	-	3	-	-	-	-	-	-
Develop the expressions for voltage and current for dc to dc converter circuits. (Unit – III)	L5	3	2	-	-	2	-	-	-	-	-	-
Solve the problems on step up and step down chopper. (Unit – IV)	L3	3	3	2	-	3	-	-	-	-	-	-
Describe the inverter operation and its application. (Unit – V)	L1	2	2	-	-	-	-	-	-	-	-	-

1 – Low, 2 – Moderate and 3 – High

Unit – IV

32. DC to DC Converter: Introduction
33. Principles of step–down operation
34. Step–down converter with RL load
35. Problems on step down converter
36. Principle of step–up converter
37. Step–up converter with Resistive load
38. Performance parameters of choppers
39. Converter classification
40. Differences between step–down and step–up operation
41. Problems on step–up converter
42. Test - II

Unit – V

43. Inverters: Introduction
44. Principles of operation of inverters
45. Performance parameters for inverters
46. Single phase bridge inverters
47. Voltage control of single phase inverters
48. Current source inverter
49. Power supplies: Introduction
50. DC power supplies
51. AC power Supplies
52. Differences between DC and AC power supplies

Course Articulation Matrix (CAM)

Course Outcome (CO)		Program Outcome (ABET/NBA-(3a-k))										
		a	b	c	d	e	f	g	h	i	j	k
Describe the working of semiconductor devices and its characteristics. (Unit – I)	L1	M	L	-	-	-	-	-	-	-	-	-
Discuss the different converters. (Unit – I)	L2	L	M	H	-	-	-	-	-	-	-	-
Design the AC voltage controllers with resistive and inductive load. (Unit – II)	L5	H	M	M	-	H	-	-	-	-	-	-
Develop the expressions for voltage and current for dc to dc converter circuits. (Unit – III)	L5	H	M	-	-	M	-	-	-	-	-	-
Solve the problems on step up and step down chopper. (Unit – IV)	L3	H	H	M	-	H	-	-	-	-	-	-
Describe the inverter operation and its application. (Unit – V)	L1	M	M	-	-	-	-	-	-	-	-	-

L- Low, M- Moderate, H-High

37. Solve the differential equations using the Laplace transformation method.
38. Identify the impulse and pulse response of RC and RL circuits.
39. Explain the ramp& pulse response.
40. Describe the concept of convolution integral.
41. Explain the concept of complex frequency.
42. Describe the network functions for one & two port networks.
43. Locate the roots of polynomial and locus of roots.
44. Identify the zeros and poles on the complex s–plane of a given two port network.
45. Express the behaviour of pole – zero plots into Time domain.
46. Assess the stability of given network's characteristic equation.
47. Distinguish the network function for one–port and two–port networks.
48. Define two-port network and its parameters.
49. Relate the different parameters like Z, Y, H and T.
50. Solve the problems on different parameters like Z, Y, H and T.

Lesson Plan

UNIT–I

1. Basic Concepts: Introduction
2. Circuit components and Definitions
3. Problems on simple circuits
4. Source of electrical energy Kirchhoff's laws
5. Problems on KVL and KCL
6. Source Transformation
7. Problems on Source Transformation
8. Mesh and Node analysis
9. Problems on mesh analysis
10. Problems on nodal analysis

UNIT–II

11. Graph Theory and Network Equation: Introduction
12. Graph of a network and Trees with problems
13. Cotres and Loops with problems
14. Incidence Matrix and Cut-Set Matrix with problems
15. Tie-Set Matrix and Loop Currents with problems
16. Number of Possible Trees of a Graph with problems
17. Analysis of Networks with problems
18. Network Equilibrium Equation with problems
19. Duality with problems
20. General Network Transformations with problems
21. Test - I

UNIT–III

22. Network Theorems: Introduction
23. Superposition theorem
24. Reciprocity theorem
25. Thevenin's theorem
26. Norton's theorem
27. Millman's theorem
28. Maximum power transfer theorem
29. Resonance: Introduction

30. Series resonance
31. Parallel resonance

UNIT–IV

32. Initial Conditions: Why study initial conditions
33. Initial conditions in elements
34. Geometrical interpretation of derivatives
35. Procedure to evaluate initial conditions
36. Initial state of a Network
37. Laplace Transformation: Introduction
38. Laplace Transformation and some basic theorems
39. Partial fraction expansion
40. The shifted unit step function
41. Ramp& Pulse response, convolution integral
42. Test - II

UNIT–V

43. Network Functions: Concept of complex frequency
44. Network functions for one & two port networks
45. Poles & zeros of network functions
46. Restrictions on pole & zero locations for driving point functions & transfer functions
47. Time domain behavior from pole – zero plots
48. Two–Port Network Parameters: Short–Circuit admittance parameters
49. Open circuit impedance parameters
50. Transmission parameters
51. Hybrid parameters
52. Relationships between parameters

40. Differentiate between the converter circuit operations.
41. Discuss the principle of operation of inverters.
42. List the performance parameters of inverters.
43. Describe the operation of single phase bridge inverters.
44. Compute the output voltage equations in a voltage controlled of single phase inverters.
45. Apply the knowledge on AC and DC power supplies.
46. List the normal specifications of a power supply.
47. Classify the different types of DC power supplies.
48. Classify the different types of AC power supplies.
49. Explain the working of a push-pull converter circuit.
50. Explain the General arrangements of an UPS.

<u>Lesson Plan</u>

Unit – I

1. Introduction to Power Semiconductor devices
2. Applications of Power electronics and power semiconductor devices
3. Control characteristics of power semiconductor devices
4. Types of Power electronic circuits
5. Peripheral effects of power electronic circuits
6. Power Transistors : BJT's
7. Steady state characteristics Switching characteristics and Switching limits
8. Power MOSFET's switching Steady state characteristics and IGBT's
9. The concepts of di/dt and dv /dt limitations
10. Isolation of gate and base drives

Unit – II

11. Thyristors : Introduction
12. Characteristics of thyristor
13. Two transistor models
14. Turn on and turn off times of an SCR
15. Thyristor types
16. The di /dt Protection for thyristor circuits
17. The dv /dt Protection for thyristor circuits
18. Thyristor types – series and parallel operation of SCR
19. Problems on series and parallel operation of SCR
20. Thyristor firing circuits
21. Test -I

Unit – III

22. AC Voltage Controllers: Introduction
23. Principles of ON– OFF control
24. Principles of Phase control
25. Single Phase bi directional controllers with resistive and inductive loads
26. Problems on Single Phase bi directional controllers with resistive and inductive loads
27. Controlled Rectifiers: Introduction
28. Principles of phase controlled converter operation
29. Single phase with problems
30. Full converter with problems
31. Dual converter (constant current operation mode only) with problems

Review Questions

1. What are the power electronic circuits and mention the power semiconductor devices?
2. What are the applications of power electronics?
3. Explain the control characteristics associated with various power semiconductor devices.
4. Explain the peripheral effects of power electronic systems and the steps to overcome the same.
5. Explain the classification of power converters.
6. Explain the steady state characteristics of BJT device.
7. Describe the various characteristics of the power MOSFET devices.
8. Explain the various characteristics of an IGBT.
9. What are the di / dt and dv / dt limitations also explain the measures to overcome the same?
10. Explain the isolation of base and gate drives.
11. Explain the concept of a two transistor model with a neat circuit.
12. Explain the characteristics, turn–on and turn–off times of a thyristor.
13. Outline the parallel operation of SCR.
14. Outline the series operation of SCR.
15. Explain the need for di / dt protection in a power electronic circuit.
16. Explain the need for dv / dt protection in a power electronic circuit.
17. Discuss the various types to trigger an SCR.
18. Explain the working principle of an SCR.
19. Generalise the equations for steady-state voltage and maximum derating factor for the series operation of SCR circuits.
20. Explain the V-I characteristics of an SCR and TRIAC.
21. Explain the principle associated with an on–off control switch.
22. Explain the principle associated with a phase control switch.
23. Compare the principles of on–off control and phase control switches.
24. Develop an equation of output voltages for an AC voltage controller with resistive and inductive loads.
25. Compute the expressions for controlled rectifiers voltage and current.
26. Explain the operation of a single phase circuit.
27. Explain the operation of a full converter circuit.
28. Explain the operation of a dual converter circuit
29. Compute an equation for output Vdc. for single phase, full converter and dual converter.
30. Differentiate between single phase, full converter and dual converter.
31. Differentiate the principles of a step–up and step–down dc chopper.
32. Explain the operation of a step–up dc chopper.
33. Explain the operation of a step–down dc chopper.
34. Develop the expressions for output voltages of a step–up dc chopper.
35. Develop the expressions for output voltages of a step–down dc chopper.
36. Compute the equations for currents and voltages for step–up and step–down dc choppers for different loads.
37. Explain the performance parameters of choppers.
38. Write the classification of step–down converters.
39. Explain the four-quadrant converter circuit.

Course Articulation Matrix (CAM)

Course Outcome (CO)		Program Outcome (ABET/NBA-(3a-k))										
		a	b	c	d	e	f	g	h	i	j	k
Apply the KVL and KCL to find out branch and loop currents and voltages in different parts of the circuits. (Unit – I)	L3	H	M	-	-	L	-	-	-	-	-	-
Sketch all possible trees of the network after drawing the corresponding graph. (Unit – II)	L3	M	M	-	-	L	-	-	-	-	-	-
Analyze the AC and DC circuits using circuit theorems like, Superposition theorem, Thevenin's theorem, Norton's theorem, Reciprocity theorem, Maximum power transfer theorem, Millman's theorem. (Unit – III)	L4	H	M	-	-	M	-	-	-	-	-	-
Examine the performance of series and parallel resonance circuits with respect to resonant frequency, reactance curves, selectivity, bandwidth and Q – factor. (Unit – III)	L4	H	L	M	-	M	-	-	-	-	-	-
Solve the network problems using Laplace transform. (Unit – IV)	L3	M	M	L	-	H	-	-	-	-	-	-
Analyze the two port networks using Impedance (Z), Admittance (Y), Hybrid (H) and transmission parameters (A, B, C and D). (Unit – V)	L4	M	H	H	-	M	-	-	-	-	-	-
L- Low, M- Moderate, H-High												

<u>Course Assessment Matrix (CAM)</u>

Course Outcome (CO)		Program Outcome (ABET/NBA-(3a-k))										
		a	b	c	d	e	f	g	h	i	j	k
Apply the KVL and KCL to find out branch and loop currents and voltages in different parts of the circuits. (Unit – I)	L3	3	2	-	-	1	-	-	-	-	-	-
Sketch all possible trees of the network after drawing the corresponding graph. (Unit – II)	L3	2	2	-	-	1	-	-	-	-	-	-
Analyze the AC and DC circuits using circuit theorems like, Superposition theorem, Thevenin's theorem, Norton's theorem, Reciprocity theorem, Maximum power transfer theorem, Millman's theorem. (Unit – III)	L4	3	2	-	-	2	-	-	-	-	-	-
Examine the performance of series and parallel resonance circuits with respect to resonant frequency, reactance curves, selectivity, bandwidth and Q – factor. (Unit – III)	L4	3	1	2	-	2	-	-	-	-	-	-
Solve the network problems using Laplace transform. (Unit – IV)	L3	2	2	1	-	3	-	-	-	-	-	-
Analyze the two port networks using Impedance (Z), Admittance (Y), Hybrid (H) and transmission parameters (A, B, C and D). (Unit – V)	L4	2	3	3	-	2	-	-	-	-	-	-
1 – Low, 2 – Moderate and 3 – High												

4. Describe the series operation of SCR. – L1
5. Explain the need for di / dt protection in a power electronic circuit. – L2
6. Explain the need for dv / dt protection in a power electronic circuit. – L2
7. Describe the various types to trigger an SCR. – L1
8. Explain the working principle of an SCR. – L2
9. Solve the problems on series and parallel operation of SCR. – L4
10. Explain the V-I characteristics of an SCR and TRIAC. – L2

After learning all the topics of UNIT – III, the student is able to

1. Explain the principle associated with an on–off control switch. – L2
2. Explain the principle associated with a phase control switch. – L2
3. Compare the principles of on–off control and phase control switches. – L3
4. Solve the problems on AC voltage controller with resistive and inductive loads. – L4
5. Compute the expressions for controlled rectifiers voltage and current. – L3
6. Explain the operation of a single phase circuit. – L2
7. Explain the operation of a full converter circuit. – L2
8. Explain the operation of a dual converter circuit. – L2
9. Solve the problems on single phase, full converter and dual converter. – L4
10. Differentiate between single phase, full converter and dual converter. – L4

After learning all the topics of UNIT – IV, the student is able to

1. Differentiate the principles of a step–up and step–down dc chopper. – L4
2. Explain the operation of a step–up dc chopper. – L2
3. Explain the operation of a step–down dc chopper. – L2
4. Develop the expressions for output voltages of a step–up dc chopper. – L5
5. Develop the expressions for output voltages of a step–down dc chopper. – L5
6. Solve the problems on step–up and step–down dc choppers for different loads. – L3
7. Analyze the performance parameters of choppers. – L4
8. Classify the step–down converters. – L2
9. Explain the four-quadrant converter circuit.
10. Differentiate between the converter circuit operations. – L4

After learning all the topics of UNIT – V, the student is able to

1. Discuss the principle of operation of inverters. – L2
2. Analyze the performance parameters of inverters. – L4
3. Describe the operation of single phase bridge inverters. – L1
4. Solve the problems on voltage controlled of single phase inverters. – L3
5. Apply the knowledge on AC and DC power supplies. – L3
6. List the normal specifications of power supply. – L1
7. Classify the different types of DC power supplies. – L2
8. Classify the different types of AC power supplies. – L2
9. Explain the working of a push-pull converter circuit. – L2
10. Explain the General arrangements of UPS. – L2

UNIT–V

Inverters: Introduction, principles of operation, performance parameters, single phase bridge inverters, voltage control of single phase inverters, current source inverter..

Power supplies: Introduction, DC Power supplies, AC Power Supplies.

Text: 6.1, 6.2, 6.3, 6.4, 6.6, 6.10, 14.1, 14.2, 14.3 **10 Hrs**

TEXT BOOK:

“Power Electronics”, M.H. Rashid 3rd edition, Prentice Hall of India Pvt. Ltd/ Pearson New Delhi Feb 2002

REFERENCE BOOKS:

1. “Power Electronics”, M.D. Singh and Khan Chandani, TMH Publishing Company Limited Reprint 2001.
2. “Power Electronics”, Cyril .W. Lander, IIIrd McGraw Hill.
3. “Power Electronics”, 2nd edition R.S. Anand Murthy and V.Nattarasu. Sanguine Technical Publishers, Bangalore.

Course Outcomes

After learning all the units of the course, the student is able to

1. Describe the working of semiconductor devices and its characteristics. – L1 (Unit – I)
2. Discuss the different converters. – L2 (Unit – I)
3. Design the AC voltage controllers with resistive and inductive load. – L5 (Unit – II)
4. Develop the expressions for voltage and current for dc to dc converter circuits. – L5 (Unit – III)
5. Solve the problems on step up and step down chopper. – L3 (Unit – IV)
6. Describe the inverter operation and its application. – L1 (Unit – V)

Topic Learning Outcomes

After learning all the topics of UNIT – I, the student is able to

1. Use the knowledge of power semiconductor devices in power electronic circuits. – L3
2. Explain the applications of power electronics. – L2
3. Discuss the control characteristics of power semiconductor devices. – L2
4. Discuss the peripheral effects of power electronics systems. – L2
5. Classify the power converters. – L2
6. Explain the steady state characteristics of BJT. – L2
7. Describe the steady state and switching characteristics of power MOSFET devices. – L1
8. Discuss the steady state and switching characteristics of IGBT’s. – L2
9. Describe the di/dt and dv/dt limitations. – L1
10. Analyze the isolation of gate and base drives. – L4

After learning all the topics of UNIT – II, the student is able to

1. Describe the concept of two transistor model. – L1
2. Explain the characteristics, turn–on and turn–off times of thyristor. – L2
3. Describe the parallel operation of SCR. – L1

Course Code : P13EC36	Semester : III	L - T - P : 4 - 0 - 0
Course Title : FUNDAMENTALS OF SIGNALS		
Contact Period: Lecture: 52 Hr, Exam: 3 Hr	Weightage:CIE:50% SEE:50%	

Prerequisite course for :

1. Digital Signal Processing – P13EC44
2. Digital Signal Processor and Applications – P13EC55
3. Digital Image Processing – P13EC61

Course Learning Objectives (CLOs)

This course aims to

1. Classify the signals and its operation on signals.
2. Recognize the basic signals like impulse, unit step, ramp, sinusoids and exponentials, represented both in frequency and time domains.
3. Represent the linear time – invariant system response to an impulse in different domains such as frequency and time domain.
4. Implement the systems in Direct-form-1 and Direct-form-2.
5. Represent the complex signals in terms of sinusoids and express the signal in time and frequency domains.
6. Explain the frequency response of systems characterized by LCC difference equation.
7. Develop the sampled version of a signal and compute the response of a LTI system to this sampled signal.
8. Show the mathematical reconstruction of the original continuous signal from its sampled version.
9. Explain the properties of Z-transform and its inverse.
10. Describe the relationship between Z transform and Fourier transform.

Course Content

UNIT – I

Signals: Definitions of signals, classification of signals, Basic Operations on signals: operations performed on the independent and dependent variable, precedence rule, elementary signals.

Systems: Definitions of systems, system viewed as interconnection of operations, properties of systems.

Text: 1.1 to 1.8 **10 Hrs**

UNIT – II

Linear time invariant systems

Discrete time systems: Convolution sum, convolution sum evaluation procedure.

Continuous time systems: Convolution integrals, convolution integrals evaluation procedure, interconnections of LTI system, relations between LTI system properties and impulse response representation, difference equation representation of LTI system and solving difference equation, block diagram representation of systems.

Text: 2.1 to 2.12 **10 Hrs**

UNIT– III

Fourier representation of continuous signals

Fourier series: Introduction, complex sinusoids and frequency response of LTI system, Fourier series representation for signals.

Fourier transform: Fourier transforms representation. Properties of Fourier transforms, inverse Fourier transform by using partial fraction expansion, Fourier transform of periodic signals, frequency response of systems characterized by LCC difference equation.

Text: 3.1, 3.2, 3.3, 3.5 3.7, 3.8, 3.9, 3.10, 3.11, 3.12, 3.14, 3.15, 3.16 **10 Hrs**

UNIT – IV

Fourier representation of discrete signals: Discrete time Fourier series, discrete time Fourier transforms. Properties of Fourier transforms, inverse Fourier transforms.

Application of Fourier representation: Sampling: sampling continuous–time signals, sampling theorem, sub–sampling: sampling discrete time signals, reconstruction of continuous time signals from samples.

Text: 3.4, 3.6, 3.8 to 3.12, 3.14 to 3.16, 4.5, 4.6 **11 Hrs**

UNIT – V

Z–Transforms: Introduction, Z – transforms properties of ROC, poles and zeros, properties of Z – transforms, inverse of Z – transforms. Partial–fraction expansion, power series expansion, transfers function, causality, stability and inverse systems. Unilateral Z transform and its application to solve difference equation. Relation between Z transform and Fourier transform.

Text: 7.1 to 7.10 **11 Hrs**

TEXT BOOK:

"Signals and Systems", Simon Haykin and Barry Van Veen, 2nd Edition John Wiley & Sons, 2nd edition 2008.

REFERENCE BOOKS:

1. "Signals and Systems", V.Oppenheim, Alan Willsky and A.Hamid Nawab, Pearson education asia/PHI, 2nd edition, 2006.
2. "Signals and systems", H.P.Hsu, R.Ranjan, Schaum's outlines, TMH, 2006.
3. "Signals and systems", Farooq Hussain, Umesh publication.
4. "Signals and systems", Ganesh rao, Singuine edition.

Course Outcomes

After learning all the units of the course, the student is able to

1. Recognize the naturally existing signals in electrical engineering context that are mathematically tractable in time and frequency. – L1 (Unit – I)
2. Define a system in electrical engineering domain as a mathematical expression in time or frequency that operates on signals. – L2 (Unit – II)
3. Express a signal and a system in both time and frequency domain. – L2 (Unit – III)
4. Develop a mathematical process to migrate between the two representations of the same entity.– L5 (Unit – III)
5. Analyze the complex signal in terms of basic signals in continuous and discrete time flavours. – L4 (Unit – IV)
6. Create the new signal from a part of original signal and reconstruct the original signal from its sampled parts. – L5 (Unit – V)

Course Code : P13EC43	Semester : IV	L - T - P : 4 - 0 - 0
Course Title : INDUSTRIAL ELECTRONICS		
Contact Period: Lecture: 52 Hr, Exam: 3 Hr	**Weightage:CIE:50% SEE:50%**	
Prerequisite course for : NIL		

Course Learning Objectives (CLOs)

This course aims to

1. Discuss the different types of power semiconductor devices, its characteristics and applications.
2. Explain the different types of power electronic circuits.
3. Provide the introduction to thyristor, its types, characteristics and firing circuit.
4. Explain the concepts of series and parallel operation of SCRs.
5. Provide the knowledge of AC voltage controllers and controlled rectifiers.
6. Explain various principles associated with on-off control and phase control,
7. Expose the concept of DC choppers, its types and applications.
8. Differentiate the step-up and step-down choppers.
9. Discuss the inverter operation, its performance parameters.
10. Explain the different types of power supplies.

Course Content

UNIT–I

Introduction to Power Semiconductor devices: Applications of Power electronics, power semiconductor devices, Control characteristics, Types of Power electronic circuits, Peripheral effects.

Power Transistors : BJT's, Steady state characteristics Switching characteristics, Switching limits, power MOSFET's switching Steady state characteristics , IGBT's, di/dt and dv /dt limitations,Isolatio0n of gate and base drives.

Text: 1.1, 1.2, 1.3, 1.5, 1.8, 4.1, 4.2, 4.3, 4.6, 4.8, 17.4 **11 Hrs**

UNIT–II

Thyristors: Introduction, characteristics, two transistor models, turn on and turn off times of an SCR, Thyristor types di /dt and dv /dt Protection Thyristor types – series and parallel operation of SCR – Thyristor firing circuits.

Text: 7.1 to 7.10, 17.5 **10 Hrs**

UNIT–III

AC Voltage Controllers: Introduction, Principles of ON– OFF and Phase control, single Phase bi directional controllers with resistive and inductive loads. Controlled Rectifiers: Introduction, Principles of phase controlled converter operation, single phase, full converter and dual converter (constant current operation mode only).

Text: 11.1 to 11.5, 10.1 to 10.4 **11 Hrs**

UNIT – IV

DC to DC Converter: Introduction , principles of step down Operation , step down Converter With RL load, Principle of step–up Converter , step–up Converter With Resistive load, performance parameters, Converter classification.

Text: 5.1 to 5.7 **10 Hrs**

Course Assessment Matrix (CAM)												
Course Outcome (CO)		**Program Outcome** (ABET/NBA-(3a-k))										
		a	**b**	**c**	**d**	**e**	**f**	**g**	**h**	**i**	**j**	**k**
Discuss AM modulation, its generation and its detection. (Unit – I)	L2	1	2	-	-	-	-	-	-	-	-	-
List the properties of Hilbert transforms. (Unit – I)	L1	2	1	-	-	-	-	-	-	-	-	-
Explain DSBSC and SSBSC modulation, its generation and its detection. (Unit – II)	L2	3	2	2	-	-	-	-	-	-	-	-
Explain the narrow-band and wide-band FM. (Unit – III)	L2	3	2	2	-	-	-	-	-	-	-	-
Explain the demodulation of FM wave and Non-linear effects in a FM system. (Unit – IV)	L2	3	3	2	-	-	-	-	-	-	-	-
Discuss the different types of noise in communication systems. (Unit – V)	L2	2	2	-	-	-	-	-	-	-	-	-
1 – Low, 2 – Moderate and 3 – High												

Topic Learning Outcomes

After learning all the topics of UNIT – I, the student is able to

1. Define the signals and a system with examples. – L1
2. Classify the different types of signals. – L2
3. Explain the basic operations on signals. – L2
4. Explain the elementary signals. – L2
5. Discuss the systems viewed as interconnections of operations. – L2
6. List the properties of systems. – L1
7. Solve the problems on properties of the systems. – L3
8. Describe the precedence rules. – L2
9. Solve the problems using precedence rules. – L3
10. Solve the problems on different types of signals. – L3

After learning all the topics of UNIT – II, the student is able to

1. Solve the convolution sum problems. – L3
2. Explain the convolution sum evaluation procedure. – L2
3. Discuss the concept of convolution integral. – L2
4. Explain the convolution integral evaluation procedure. – L2
5. Explain the inter connections of LTI systems. – L2
6. Discuss the relation between LTI system properties and impulse response. – L2
7. Explain the difference equation representations of LTI system. – L2
8. Solve the differential and difference equations. – L3
9. Discuss the characteristics of system described by differential and difference equation. – L2
10. Explain the block diagram representations. – L2

After learning all the topics of UNIT – III, the student is able to

1. Discuss the complex sinusoids and frequency response of LTI systems. – L2
2. Explain the Fourier representations for four classes of signals. – L2
3. Describe the discrete time periodic signals. – L2
4. Solve the problems on discrete time Fourier series and continuous time periodic signals. – L3
5. Discuss the Fourier series (derivation of series included) and their properties. – L2
6. Explain the discrete time non periodic signals. – L2
7. Solve the discrete time Fourier transform. – L3
8. Explain the continuous time non periodic signals. – L2
9. Develop the Fourier transforms expression. – L3
10. Discuss the properties of Fourier representation. – L2

After learning all the topics of UNIT – IV, the student is able to

1. Explain the applications of Fourier representations. – L2
2. Explain the basic concept of sampling. – L2
3. Describe the reconstruction of continuous time signals from samples. – L1
4. Solve the problems on sampling. – L3
5. Explain the discrete time processing of continuous time signal. – L2
6. Describe the properties of fourier transform. – L2
7. Solve the problems on fourier transform. – L3

1. Describe the ROC and its applications. – L2
2. Define the inverse-fourier transform. – L1
3. Solve the problems on inverse-fourier transform. – L3

After learning all the topics of UNIT – V, the student is able to

1. Explain the basics of Z – transform. – L2
2. Discuss the properties of ROC. – L2
3. Discuss the properties of Z – transforms. – L2
4. Solve the problems on Z– transform. – L3
5. Explain the inversion of Z – transforms. – L2
6. Explain the transfer function of Z–transform. – L2
7. Discuss the causality and stability properties using Z–transform. – L2
8. Explain unilateral Z – Transforms. – L2
9. Explain the applications of Z – transform to solve difference equations. – L2
10. Solve the problems on unilateral Z – Transforms. – L3

Review Questions

1. Define the signals and a system with examples.
2. Classify the different types of signals.
3. Explain the basic operations on signals.
4. Explain the elementary signals.
5. Discuss the systems viewed as interconnections of operations.
6. List the properties of systems.
7. Solve the problems on properties of the systems.
8. Describe the precedence rules.
9. Solve the problems using precedence rules.
10. Solve the problems on different types of signals.
11. Solve the convolution sum problems.
12. Explain the convolution sum evaluation procedure.
13. Discuss the concept of convolution integral.
14. Explain the convolution integral evaluation procedure.
15. Explain the inter connections of LTI systems.
16. Discuss the relation between LTI system properties and impulse response.
17. Explain the difference equation representations of LTI system.
18. Solve the differential and difference equations.
19. Discuss the characteristics of system described by differential and difference equation.
20. Explain the block diagram representations.
21. Discuss the complex sinusoids and frequency response of LTI systems.
22. Explain the Fourier representations for four classes of signals.
23. Describe the discrete time periodic signals.
24. Solve the problems on discrete time Fourier series and continuous time periodic signals.
25. Discuss the Fourier series (derivation of series included) and their properties.
26. Explain the discrete time non periodic signals.
27. Solve the discrete time Fourier transform.
28. Explain the continuous time non periodic signals.
29. Develop the Fourier transforms expression.
30. Discuss the properties of Fourier representation.

Course Articulation Matrix (CAM)

Course Outcome (CO)		Program Outcome (ABET/NBA-(3a-k))										
		a	**b**	**c**	**d**	**e**	**f**	**g**	**h**	**i**	**j**	**k**
Discuss AM modulation, its generation and its detection. (Unit – I)	L2	L	M	-	-	-	-	-	-	-	-	-
List the properties of Hilbert transforms. (Unit – I)	L1	M	L	-	-	-	-	-	-	-	-	-
Explain DSBSC and SSBSC modulation, its generation and its detection. (Unit – II)	L2	H	M	M	-	-	-	-	-	-	-	-
Explain the narrow-band and wide-band FM. (Unit – III)	L2	H	M	M	-	-	-	-	-	-	-	-
Explain the demodulation of FM wave and Non-linear effects in a FM system. (Unit – IV)	L2	H	H	M	-	-	-	-	-	-	-	-
Discuss the different types of noise in communication systems. (Unit – V)	L2	M	M	-	-	-	-	-	-	-	-	-
L- Low, M- Moderate, H-High												

18. Coherent detection of SSB –SC waves
19. Frequency Translation and FDM
20. Numerical Problems
21. Test - I

UNIT – III

22. Vestigial side band modulation
23. Generation of VSB – SC waves
24. Detection of VSB – SC waves and associated problems,
25. Television and Color television
26. Angle Modulation: Introduction
27. Time domain representation of FM waves
28. Time domain representation of Phase modulated waves
29. Frequency deviation and modulation index
30. Narrow band frequency modulation
31. Numerical problems

UNIT – IV

32. Wideband Frequency Modulation
33. Transmission BW of FM waves
34. Generation of Narrowband Angle
35. Modulated Signal: phase modulation and frequency modulation
36. Generation of FM wave: Indirect and direct Methods
37. Numerical problems
38. Demodulation of FM signals: Introduction
39. Frequency Discrimination
40. FM demodulation using PLL
41. Non linear Effects in FM systems and FM stereo Multiplexing
42. Test - II

UNIT – V

43. Noise: External Noise, Extraterrestrial noise and Internal Noise
44. Thermal noise and White noise
45. Noise Equivalent Bandwidth
46. Narrowband noise, Noise figure
47. Equivalent noise temperature
48. Cascade connection of noisy networks and related problems
49. Noise in continuous–wave modulation systems: Receiver model
50. Noise in DSB –SC receivers and Noise in SSB – SC receivers
51. Noise in AM receivers and Noise in FM receivers
52. Threshold effect in FM, Pre – emphasis and De – emphasis in FM

31. Explain the applications of Fourier representations.
32. Explain the basic concept of sampling.
33. Describe the reconstruction of continuous time signals from samples.
34. Solve the problems on sampling.
35. Explain the discrete time processing of continuous time signal.
36. Describe the properties of fourier transform.
37. Solve the problems on fourier transform.
38. Describe the ROC and its applications.
39. Define the inverse-fourier transform.
40. Solve the problems on inverse-fourier transform.
41. Explain the basics of Z – transform.
42. Discuss the properties of ROC.
43. Discuss the properties of Z – transforms.
44. Solve the problems on Z– transform.
45. Explain the inversion of Z – transforms.
46. Explain the transfer function of Z–transform.
47. Discuss the causality and stability properties using Z–transform.
48. Explain unilateral Z – Transforms.
49. Explain the applications of Z – transform to solve difference equations.
50. Solve the problems on unilateral Z – Transforms.

<u>Lesson Plan</u>

UNIT – I

1. Signals: Definitions of signals
2. Classification of signals
3. Basic Operations on signals:
4. Operations performed on the independent variable
5. Operations performed on the dependent variable
6. Precedence rule
7. Elementary signals
8. Systems: Definitions of systems
9. System viewed as interconnection of operations
10. Properties of systems

UNIT – II

11. Linear time invariant systems
12. Discrete time systems: Convolution sum
13. Convolution sum evaluation procedure
14. Continuous time systems: Introduction
15. Convolution integrals
16. Convolution integrals evaluation procedure
17. Interconnections of LTI system
18. Relations between LTI system properties and impulse response representation
19. Difference equation representation of LTI system and solving difference equation
20. Block diagram representation of systems
21. Test - I

UNIT– III

22. Fourier representation of continuous signals
23. Fourier series: Introduction

24. Frequency response of LTI system
25. Complex sinusoids
26. Fourier series representation for signals
27. Fourier transform: Fourier transforms representation
28. Properties of Fourier transforms
29. Inverse Fourier transform by using partial fraction expansion
30. Fourier transform of periodic signals
31. Frequency response of systems characterized by LCC difference equation

UNIT – IV

32. Fourier representation of discrete signals
33. Discrete time Fourier series
34. Discrete time Fourier transforms
35. Properties of Fourier transforms
36. Inverse Fourier transforms
37. Application of Fourier representation
38. Sampling: sampling continuous–time signals
39. Sampling theorem
40. Sub–sampling: sampling discrete time signals
41. Reconstruction of continuous time signals from samples
42. Test - II

UNIT – V

43. Z–Transforms: Introduction,
44. Z – transforms properties of ROC,
45. Poles and zeros, properties of Z – transforms,
46. Inverse of Z – transforms.
47. Partial–fraction expansion,
48. Power series expansion,
49. Transfers function, causality,
50. Stability and inverse systems.
51. Unilateral Z transform and its application to solve difference equation.
52. Relation between Z transform and Fourier transform.

32. Describe the transmission BW of FM waves.
33. Explain the generation of narrowband angle modulated signal.
34. An FM wave has a sinusoidal modulation with f_m = 15 KHZ and the modulation index β = 2. Using carson's rule find the transmission bandwidth.
35. Explain the indirect and direct methods of generating WBFM wave.
36. Explain the demodulation of FM by frequency discrimination method.
37. Explain the balanced frequency discrimination.
38. What is PLL? Explain how linearized and non-linearized model of PLL is obtained.
39. Mention the types of non-linearity. Explain the non-linear effects in FM systems.
40. Write the neat block diagram of FM stereo multiplexing. Explain.
41. Discuss the different types of noise.
42. Explain the noise equivalent bandwidth.
43. Discuss the narrowband noise.
44. Derive the noise figure of a linear two-port device.
45. Derive the equation for the equivalent noise temperature of a linear two-port device.
46. Formulate the equation for cascade connection of noisy networks.
47. Two two-port devices are connected in cascade. For the first stage the noise figure and the available power gain are 5 dB and 12 dB respectively. For the second stage, the noise figure and the available power gain are 15 dB and 10 dB respectively. Determine the overall noise figure in dB.
48. Show that figure of merit in SSBSC receiver is unity.
49. Describe the threshold effect in FM system.
50. Explain the Pre – emphasis and De – emphasis in FM.

Lesson Plan

UNIT – I

1. Amplitude Modulation: Introduction and definitions
2. Base band and Band pass and Modulation
3. Block diagram of a Communication system
4. Types of Analog Modulation, Hilbert transform
5. The analytic signal and Envelopes
6. Amplitude Modulation (standard) and single tone standard AM
7. Generation of AM wave
8. Switching Modulator and Square Law Modulator
9. Demodulation of AM waves: coherent detection of AM waves, square law detector and envelope detector,
10. Numerical Problems

UNIT – II

11. DSBSC Modulation: Introduction
12. DSBSC modulators: balanced modulator, ring modulator
13. Demodulation of DSBSC wave: Coherent/synchronous detection of DSB–SC modulated waves
14. Costas receiver and carrier Re– insertion Technique
15. Quadrature carrier multiplexing
16. SSB –SC Modulation: Time–Domain description of SSB–SC waves,
17. Generation of SSB– SC waves

7. Solve the problems on noise figure, equivalent noise temperature, and cascade connection of noisy networks. – L3
8. Explain the receiver model, noise in DSBSC, SSBSC, AM, and FM receivers – L2
9. Describe the threshold effect in FM system. – L2
10. Explain the Pre – emphasis and De – emphasis in FM – L1

Review Questions

1. What is modulation? Explain the need for modulation.
2. Explain the basic block diagram of communication systems.
3. Discuss the Hilbert transform and its properties.
4. For the AM signal $S(t) = m(t) \cos(2\pi f_c t + \Phi)$ find the following. (i) Pre-envelope, (ii) Complex envelope, (iii) Natural envelope and (iv) In-phase and quadrature components.
5. With required equations and spectrum explain the switching modulator.
6. With required equations and spectrum describe the square law modulator.
7. Explain how the AM wave is detected using coherent detector.
8. Discuss the square law detector with specific equations and spectrum.
9. Explain the envelope detector of an AM wave.
10. Show that in an AM wave, $P_t = (1.5)\ P_c$.
11. Mention the advantage of DSBSC over AM.
12. Explain the working of balanced modulator and ring modulator.
13. Explain the coherent detection of DSBSC modulated waves.
14. Explain how DSBSC wave is detected using negative feedback system.
15. Consider the composite wave that is obtained by adding non-coherent carrier $A_c \cos(2\pi f_c t + \Phi)$ to a DSBSC wave $m(t) = \cos(2\pi f_c t)$. The composite wave is then applied to an envelope detector. Evaluate the detector output for $\Phi \neq 0$, $[|m(t)| << (A_c / 2)]$.
16. Describe the transmitter and receiver section of quadrature-carrier multiplexing.
17. List the advantages of SSBSC over DSBSC and AM waves.
18. Describe the generation of SSB–SC waves using frequency discrimination method.
19. Define multiplexing? With block diagram explain FDM.
20. In an SSBSC system LSB of message signal is transmitted. The local carrier at the receiver has no frequency error but a phase error of θ radians. Discuss the effect of phase error on the demodulated signal.
21. List the advantages of VSBSC over SSBSC modulation.
22. Explain the generation of VSBSC waves using filtering technique.
23. Discuss the detection of VSBSC waves using coherent detector.
24. Write the block diagram of TV transmitter and receiver.
25. Explain the TV transmitter and receiver.
26. Discuss the types of angle modulation.
27. Derive the fundamental time domain representation of FM waves.
28. Derive the fundamental time domain representation of PM waves.
29. Derive the time domain equation of Narrow band FM waves. How it differs from AM wave. Explain with the phasor diagram.
30. Find the modulation index β of an FM wave, whose frequency deviation is 2 KHZ and the modulating signal frequency is 500 HZ.
31. Show that the WBFM have infinite number of sidebands.

Course Articulation Matrix (CAM)

Course Outcome (CO)		Program Outcome (ABET/NBA-(3a-k))										
		a	b	c	d	e	f	g	h	i	j	k
Recognize the naturally existing signals in electrical engineering context that are mathematically tractable in time and frequency. (Unit – I)	L1	M	L	L	-	-	-	-	-	-	-	-
Define a system in electrical engineering domain as a mathematical expression in time or frequency that operates on signals. (Unit – II)	L2	M	L	-	-	-	-	-	-	-	-	-
Express a signal and a system in both time and frequency domain. (Unit – III)	L2	M	L	L	-	-	-	-	-	-	-	-
Develop a mathematical process to migrate between the two representations of the same entity. (Unit – III)	L5	H	M	M	-	-	-	-	-	-	-	-
Analyze the complex signal in terms of basic signals in continuous and discrete time flavours. (Unit – IV)	L4	H	M	M	-	-	-	-	-	-	-	-
Create the new signal from a part of original signal and reconstruct the original signal from its sampled parts. (Unit – V)	L5	H	M	L	-	-	-	-	-	-	-	-

L- Low, M- Moderate, H-High

Course Assessment Matrix (CAM)												
Course Outcome (CO)		**Program Outcome** (ABET/NBA-(3a-k))										
		a	**b**	**c**	**d**	**e**	**f**	**g**	**h**	**i**	**j**	**k**
Recognize the naturally existing signals in electrical engineering context that are mathematically tractable in time and frequency. (Unit – I)	L1	2	1	1	-	-	-	-	-	-	-	-
Define a system in electrical engineering domain as a mathematical expression in time or frequency that operates on signals. (Unit – II)	L2	2	1	-	-	-	-	-	-	-	-	-
Express a signal and a system in both time and frequency domain. (Unit – III)	L2	2	1	1	-	-	-	-	-	-	-	-
Develop a mathematical process to migrate between the two representations of the same entity. (Unit – III)	L5	3	2	2	-	-	-	-	-	-	-	-
Analyze the complex signal in terms of basic signals in continuous and discrete time flavours. (Unit – IV)	L4	3	2	2	-	-	-	-	-	-	-	-
Create the new signal from a part of original signal and reconstruct the original signal from its sampled parts. (Unit – V)	L5	3	2	1	-	-	-	-	-	-	-	-
1 – Low, 2 – Moderate and 3 – High												

6. Describe the square law modulator. – L2
7. Explain the coherent detection of AM waves. – L2
8. Discuss the square law detector
9. Explain the envelope detector. – L2
10. Solve the problems on AM techniques. – L3

After learning all the topics of UNIT – II, the student is able to

1. List the advantage of DSBSC over AM. – L1
2. Explain the working of balanced modulator and ring modulator. – L2
3. Explain the coherent detection of DSBSC modulated waves
4. Describe the operation of costas receiver. – L2
5. Explain the carrier re– insertion technique. – L2
6. Describe the quadrature carrier multiplexing. – L2
7. Outline the advantages of SSBSC over DSBSC and AM waves. – L1
8. Describe the time–domain description of SSB–SC waves, generation of SSB–SC waves, and coherent detection of SSB –SC waves. – L1
9. Explain the frequency translation and FDM. – L2
10. Solve the problems on DSBSC and SSBSC modulation techniques. – L3

After learning all the topics of UNIT – III, the student is able to

1. List the advantages of VSBSC over SSBSC modulation. – L1
2. Explain the generation of VSBSC waves. – L2
3. Discuss the detection of VSBSC waves. – L2
4. Write the block diagram of TV transmitter and receiver. – L3
5. Explain the TV transmitter and receiver. – L2
6. Discuss the types of angle modulation. – L2
7. Describe the time domain representation of FM waves. – L2
8. Explain the PM wave. – L2
9. Explain the Narrow band FM waves. – L2
10. Solve the problems on FM and PM waves. – L3

After learning all the topics of UNIT –IV, the student is able to

1. Show that the WBFM have infinite number of sidebands. – L3
2. Describe the transmission BW of FM waves. – L2
3. Explain the generation of narrowband angle modulated signal. – L1
4. Solve the problems on BW of FM wave. – L3
5. Explain the indirect and direct methods of generating WBFM wave. – L2
6. Explain the demodulation of FM by frequency discrimination method. – L2
7. Explain the balanced frequency discrimination. – L2
8. Describe the FM demodulation using PLL. – L2
9. Describe the non linear effects in FM systems. – L2
10. Explain the FM stereo multiplexing. – L2

After learning all the topics of UNIT – V, the student is able to

1. Discuss the different types of noise. – L2
2. Explain the noise equivalent bandwidth. – L2
3. Discuss the narrowband noise. – L2
4. Describe the noise figure. – L2
5. Explain the equivalent noise temperature. – L2
6. Formulate the equation for cascade connection of noisy networks. – L5

Angle Modulation: Time domain representation of FM waves, Time domain representation of Phase modulated waves, Frequency deviation and modulation index, Narrow band frequency modulation, Numerical problems.
Text: 2.28 to 2.32, 3.1 to 3.4 **11 Hrs**

UNIT – IV

Wideband Frequency Modulation, Transmission BW of FM waves, Generation of Narrowband Angle.
Modulated Signal: phase modulation and frequency modulation, Generation of FM wave: Indirect and direct Methods, Numerical problems.
Demodulation of FM signals: frequency Discrimination, FM demodulation using PLL, Non linear Effects in FM systems, FM stereo Multiplexing.
Text: 3.5 to 3.14 **10 Hrs**

UNIT – V

Noise: External Noise, Extraterrestrial noise, Internal Noise, Thermal noise, White noise, Noise Equivalent Bandwidth, Narrowband noise, Noise figure, Equivalent noise temperature, Cascade connection of noisy networks and related problems.
Noise in continuous–wave modulation systems: Receiver model, Noise in DSB – SC receivers, Noise in SSB – SC receivers, Noise in AM receivers, Noise in FM receivers, Threshold effect in FM, Pre – emphasis and De – emphasis in FM.
Text: 5.1 to 5.5, 5.8, 5.9, 5.12 to 5.14, 6.1 to 6.7 **11 Hrs**

TEXT BOOK:

"Analog Communications", by Dr. K. N. Hari Bhat& Dr. D. Ganesh Rao, 2nd Edition 2008; Sanguine Technical publications, Bangalore.

REFERENCE BOOKS:

1. "Communication Systems" – Simon Haykin, 3rd edition, John Wiley, 1996.
2. "Analog Communication systems" by P. Chakrabarthy 1st edition 1998: Dhanpat Rai & Co. Reprint 2001.

Course Outcomes

After learning all the units of the course, the student is able to
1. Discuss AM modulation, its generation and its detection. – L2 (Unit – I)
2. List the properties of Hilbert transforms. – L1 (Unit – I)
3. Explain DSBSC and SSBSC modulation, its generation and its detection. – L2 (Unit – II)
4. Explain the narrow-band and wide-band FM. – L2 (Unit – III)
5. Explain the demodulation of FM wave and Non-linear effects in a FM system. – L2 (Unit – IV)
6. Discuss the different types of noise in communication systems. – L2 (Unit – V)

Topic Learning Outcomes

After learning all the topics of UNIT – I, the student is able to
1. Describe what is modulation, why modulation is required and types of analog modulation. – L1
2. Explain the basic block diagram of communication systems. – L2
3. Discuss the Hilbert transform and its properties. – L2
4. Explain the analytic signal and envelopes of modulated signal. – L2
5. Explain the switching modulator. – L2

Course Code : P13ECL37	**Semester : III**	**L - T - P : 0 - 0 - 1.5**
Course Title : FET AND OP–AMP CIRCUITS LABORATORY		
Contact Period: Lecture: 36 Hr, Exam: 3 Hr	**Weightage:CIE:50% SEE:50%**	
Prerequisite course for : NIL		

Course Learning Objectives (CLOs)

This course aims to
1. Provide the basic knowledge of how to use CRO, signal generator, bread board, power supply and how to rig–up the circuits.
2. Outline the characteristics curve of JFET and MOSFET.
3. Outline the gain– frequency response, input and output impedances of RC coupled Single –stage MOSFET amplifier
4. Design the MOSFET phase shift, Hartley and Colpitts oscillators.
5. Experiment the characteristic of Op–Amp.
6. Construct the Inverting and Non–inverting Op–Amp circuit.
7. Experiment the Summing, Subtracting and voltage follower using Op–Amp.
8. Demonstrate the working of Integrator and Differentiating circuit.
9. Experiment the working of precision half wave and full wave rectifier.
10. Design the Schmitt trigger and zero crossing detection.
11. Demonstrate the working DAC using Op–Amp.
12. Demonstrate the voltage regulator using LM 217 IC.

Course Content

EXPERIMENTS:

1. Determination of input and output characteristics for JFET and MOSFET.
2. Wiring of RC coupled single stage MOSFET amplifier and determination of the gain vs frequency Curve, input and output impedances.
3. Demonstration of MOSFET RC phase shift oscillator for a given frequency.
4. Demonstration of Hartley and Colpitts oscillator using MOSFET.
5. Determination of characteristic parameters of Op–Amp.
6. Conduction of experiments on Inverting and Non–inverting Op–Amp amplifier for different gains and observation of waveforms.
7. Verification of applications of Op–amp as summer, subtractor and voltage follower.
8. Verification of applications of Op–amp as Integrator and Differentiator circuit and observation of waveforms.
9. Conduction of experiments on Precision half wave and full wave rectifier and observation of waveforms.
10. Demonstration of Schmitt triggers and zero crossing detector circuits.
11. Demonstration of R–2R DAC using Op–amp.
12. Demonstration of voltage regulator using LM 217 IC and calculation of percentage regulations.

Course Outcomes

After conducting all the experiments, the student is able to

1. Sketch the input and output characteristics of JFET and MOSFET. – L3
2. Experiment on the RC coupled single stage MOSFET amplifier to determine the gain–frequency response curve, input and output impedances. – L4
3. Design the RC phase shift oscillator using MOSFET. – L4
4. Design the Hartley and colpitts oscillator using MOSFET. – L4
5. Construct the circuit using Op–amp to obtain its transfer characteristic. – L5
6. Analyse the Inverting and Non–inverting Op–Amp. – L4
7. Experiment on the working of summer, subtractor and voltage follower using Op–Amp. – L4
8. Demonstrate the working of integrator and Differentiator of Op–Amp. – L3
9. Experiment on the working of Precision half wave and full wave rectifier using Op–Amp. – L4
10. Design the Schmitt trigger and zero crossing detector using Op–Amp. – L4
11. Demonstrate the working of R–2R DAC. – L3
12. Construct the voltage regulator using LM217 IC. – L5

Course Code : P13EC42	Semester : IV	L - T - P : 4 - 0 - 0
Course Title : ANALOG COMMUNICATION THEORY		
Contact Period: Lecture: 52 Hr, Exam: 3 Hr	Weightage:CIE:50% SEE:50%	

Prerequisite course for :

1. Optical Communication Systems – P13EC56.
2. Satellite Communication – P13EC81

Course Learning Objectives (CLOs)

This course aims to

1. Provide the basic knowledge of analog modulation and its types.
2. Explain the generation and detection of AM waves using different techniques.
3. Explain the DSBSC and SSBSC modulation techniques, generation and detection, as well as frequency translation and FDM.
4. Describe the advantages of SSBSC over DSBSC and AM.
5. Describe the generation of VSB and its demodulation as well as TV block diagram.
6. Discuss the significance of angle modulation, frequency deviation and modulation index.
7. Explain the wideband frequency modulation, transmission BW and generation of FM wave.
8. Explain the demodulation of FM signals, non linear effects in FM systems and FM stereo multiplexing.
9. Describe the different types of noise, noise in continuous–wave modulation systems and pre–emphasis and de–emphasis in FM.
10. Describe receiver models of different modulated waves and threshold effects.

Course Content

UNIT – I

Amplitude Modulation : Introduction, definitions , Base band , Band pass and Modulation , Block diagram of a Communication system , Types of Analog Modulation, Hilbert transform, The analytic signal and Envelopes, Amplitude Modulation (standard), single tone standard AM.Generation of AM wave, Switching Modulator, Square Law Modulator, Demodulation of AM waves, coherent detection of AM waves, square law detector, envelope detector, Numerical Problems.

Text: 2.1 to 2.5, 2.7 to 2.16 **10 Hrs**

UNIT – II

DSBSC Modulation: DSBSC modulators: balanced modulator, ring modulator, Demodulation of DSBSC wave: Coherent/synchronous detection of DSB–SC modulated waves, Costas receiver, carrier Re– insertion Technique, and Quadrature carrier multiplexing.

SSB –SC Modulation: Time–Domain description of SSB–SC waves, generation of SSB– SC waves, Coherent detection of SSB –SC waves, Frequency Translation, FDM, Numerical Problems.

Text: 2.17 to 2.27 **10 Hrs**

UNIT – III

Vestigial side band modulation, Generation of VSB – SC waves, detection of VSB – SC waves and associated problems, Television, Color television.

Course Assessment Matrix (CAM)												
Course Outcome (CO)		Program Outcome (ABET/NBA-(3a-k))										
		a	b	c	d	e	f	g	h	i	j	k
Demonstrate the working of logic gates for the given Boolean expression.	L3	2	2	-	-	-	-	-	-	-	-	-
Design the half and full adder, half and full subtractor using logic gates.	L5	3	3	2	-	-	-	-	-	-	-	-
Use the parallel adder and parallel subtractor to realize BCD to Excess–3 code conversion and vice versa.	L3	3	2	-	-	-	-	-	-	-	-	-
Design the Binary to Gray code converter and vice versa using logic gates.	L5	3	3	3	-	-	-	-	-	-	-	-
Construct the AND, OR, NOT, NAND, NOR, XOR and XNOR logic gates using MUX.	L3	3	2	-	-	-	-	-	-	-	-	-
Use the MUX and DEMUX chips to realize half and full adders, half and full subtractors and code converter respectively.	L3	2	2	-	-	-	-	-	-	-	-	-
Design the two bit comparator using logic gates and four bit comparator using 7485 chip.	L5	3	3	3	-	-	-	-	-	-	-	-
Use the decoder chip to drive LED display.	L3	2	3	-	-	-	-	-	-	-	-	-
Demonstrate the functionality of a Priority Encoder using 74147 chip.	L3	2	2	-	-	-	-	-	-	-	-	-
Verify the truth table for the Flip–Flops: (i) T type (ii) D type and iii) JK Master slave type.	L4	3	2	-	-	-	-	-	-	-	-	-
Design of 3 bit binary, decade and MOD – N counters using 7476, 7490, 74192/74193 chips respectively.	L5	2	3	3	-	-	-	-	-	-	-	-
Demonstrate the shift left, shift right, SIPO, SISO, PISO and PIPO operations using 7495.	L3	3	2	-	-	-	-	-	-	-	-	-
Test the Ring counter and Johnson counter operations using 7495.	L4	3	2	-	-	-	-	-	-	-	-	-
1 – Low, 2 – Moderate and 3 – High												

Course Articulation Matrix (CAM)												
Course Outcome (CO)		Program Outcome (ABET/NBA-(3a-k))										
		a	b	c	d	e	f	g	h	i	j	k
Sketch the input and output characteristics of JFET and MOSFET.	L3	H	L		-	-	-	-	-	-	-	-
Experiment on the RC coupled single stage MOSFET amplifier to determine the gain–frequency response curve, input and output impedances.	L4	M	M		-	-	-	-	-	-	-	-
Design the RC phase shift oscillator using MOSFET.	L4	M	H	H	-	-	-	-	-	-	-	-
Design the Hartley and colpitts oscillator using MOSFET.	L4	L	H	H	-	-	-	-	-	-	-	-
Construct the circuit using Op–amp to obtain its transfer characteristic.	L5	M	L		-	-	-	-	-	-	-	-
Analyse the Inverting and Non–inverting Op–Amp.	L4	M	L		-	-	-	-	-	-	-	-
Experiment on the working of summer, subtractor and voltage follower using Op –Amp.	L4	H	M		-	-	-	-	-	-	-	-
Demonstrate the working of integrator and Differentiator of Op–Amp.	L3	H	M		-	-	-	-	-	-	-	-
Experiment on the working of Precision half wave and full wave rectifier using Op–Amp.	L4	H	M		-	-	-	-	-	-	-	-
Design the Schmitt trigger and zero crossing detector using Op–Amp.	L4	M	H	H	-	-	-	-	-	-	-	-
Demonstrate the working of R–2R DAC.	L3	M	L		-	-	-	-	-	-	-	-
Construct the voltage regulator using LM217 IC.	L5	M	H	M	-	-	-	-	-	-	-	-
L- Low, M- Moderate, H-High												

Course Assessment Matrix (CAM)

Course Outcome (CO)		Program Outcome (ABET/NBA-(3a-k))										
		a	b	c	d	e	f	g	h	i	j	k
Sketch the input and output characteristics of JFET and MOSFET.	L3	3	1	-	-	-	-	-	-	-	-	-
Experiment on the RC coupled single stage MOSFET amplifier to determine the gain–frequency response curve, input and output impedances.	L4	2	2	-	-	-	-	-	-	-	-	-
Design the RC phase shift oscillator using MOSFET.	L4	2	3	3	-	-	-	-	-	-	-	-
Design the Hartley and colpitts oscillator using MOSFET.	L4	1	3	3	-	-	-	-	-	-	-	-
Construct the circuit using Op–amp to obtain its transfer characteristic.	L5	2	1	-	-	-	-	-	-	-	-	-
Analyse the Inverting and Non–inverting Op–Amp.	L4	2	1	-	-	-	-	-	-	-	-	-
Experiment on the working of summer, subtractor and voltage follower using Op –Amp.	L4	3	2	-	-	-	-	-	-	-	-	-
Demonstrate the working of integrator and Differentiator of Op–Amp.	L3	3	2	-	-	-	-	-	-	-	-	-
Experiment on the working of Precision half wave and full wave rectifier using Op–Amp.	L4	3	2	-	-	-	-	-	-	-	-	-
Design the Schmitt trigger and zero crossing detector using Op–Amp.	L4	2	3	3	-	-	-	-	-	-	-	-
Demonstrate the working of R–2R DAC.	L3	2	1	-	-	-	-	-	-	-	-	-
Construct the voltage regulator using LM217 IC.	L5	2	3	2	-	-	-	-	-	-	-	-

1 – Low, 2 – Moderate and 3 – High

Course Articulation Matrix (CAM)

Course Outcome (CO)		Program Outcome (ABET/NBA-(3a-k))										
		a	b	c	d	e	f	g	h	i	j	k
Demonstrate the working of logic gates for the given Boolean expression.	L3	M	M	-	-	-	-	-	-	-	-	-
Design the half and full adder, half and full subtractor using logic gates.	L5	H	H	M	-	-	-	-	-	-	-	-
Use the parallel adder and parallel subtractor to realize BCD to Excess–3 code conversion and vice versa.	L3	H	M	-	-	-	-	-	-	-	-	-
Design the Binary to Gray code converter and vice versa using logic gates.	L5	H	H	H	-	-	-	-	-	-	-	-
Construct the AND, OR, NOT, NAND, NOR, XOR and XNOR logic gates using MUX.	L3	H	M	-	-	-	-	-	-	-	-	-
Use the MUX and DEMUX chips to realize half and full adders, half and full subtractors and code converter respectively.	L3	M	M	-	-	-	-	-	-	-	-	-
Design the two bit comparator using logic gates and four bit comparator using 7485 chip.	L5	H	H	H	-	-	-	-	-	-	-	-
Use the decoder chip to drive LED display.	L3	M	H	-	-	-	-	-	-	-	-	-
Demonstrate the functionality of a Priority Encoder using 74147 chip.	L3	M	M	-	-	-	-	-	-	-	-	-
Verify the truth table for the Flip–Flops: (i) T type (ii) D type and iii) JK Master slave type.	L4	H	M	-	-	-	-	-	-	-	-	-
Design of 3 bit binary, decade and MOD –N counters using 7476, 7490, 74192/74193 chips respectively.	L5	M	H	H	-	-	-	-	-	-	-	-
Demonstrate the shift left, shift right, SIPO, SISO, PISO and PIPO operations using 7495.	L3	H	M	-	-	-	-	-	-	-	-	-
Test the Ring counter and Johnson counter operations using 7495.	L4	H	M	-	-	-	-	-	-	-	-	-

L- Low, M- Moderate, H-High

Course Code : P13ECL38	**Semester : III**	**L - T - P : 0 - 0 - 1.5**
Course Title : DIGITAL CIRCUITS DESIGN LAB		
Contact Period: Lecture: 36 Hr, Exam: 3 Hr	**Weightage:CIE:50% SEE:50%**	
Prerequisite course for : NIL		

Course Learning Objectives (CLOs)

This course aims to

1. Provide the basic knowledge of how to use digital trainer kit and digital IC connections.
2. Help the designer to simplify and realize the Boolean expressions.
3. Provide the techniques to realize the half and full adder as well as half and full Subtractor.
4. Aid the circuit designer to realize the parallel adder and parallel Subtractor.
5. Provide the idea to design the Binary to Gray Code conversion circuit.
6. Construct all the gates using MUX.
7. Provide the understanding of the MUX and DE–MUX ICs and its use.
8. Help the designer to realize the 2–bit and 4–bit comparators.
9. Provide the knowledge of decoder applications to drive seven segment displays.
10. Provide the ideas of truth tables of JK, T and D flip flops.
11. Help the designer to realize the different types of counters.
12. Give the understanding of the operation of the shift–register.
13. Demonstrate the Ring Counter and Johnson Counter operations.

Course Content

EXPERIMENTS:

1. Simplification, realization of Boolean expressions using logic gates and Universal gates.
2. Realization of half and full adders, half and full subtractor using logic gates.
3. a. Realization of parallel adder and parallel subtractor using 7483 chip
   b. Demonstration of BCD to Excess–3 code conversion and vice versa.
4. Realization of Binary to Gray code conversion and vice versa.
5. Realization of AND, OR, NOT, NAND, NOR, XOR and XNOR logic gates using MUX.
6. Application of the IC's – MUX–74153 for half and full adders, half and full subtractors and DEMUX – 74139 for 3 – bit binary to gray and BCD to Excess–3 code converters.
7. Realization of 2 – bit comparator using gates and 4 bit comparator using 7485 chip.
8. i) Application of Decoder chip to drive LED display. ii) Demonstration of Priority encoder using 74147.
9. Truth table verification of Flip–Flops: (i) T type (ii) D type and iii) J–K Master slave.
10. Realization of 3 bit binary, decade and MOD – N counters using 7476, 7490, 74192/74193 chips respectively.
11. Realization of Shift left, Shift right, SIPO, SISO, PISO, PIPO register operations using 7495.
12. Demonstration of Ring counters and Johnson counter.

Course Outcomes

After conducting all the experiments the student is able to

1. Demonstrate the working of logic gates for the given Boolean expression. – L3
2. Design the half and full adder, half and full subtractor using logic gates. – L5
3. Use the parallel adder and parallel subtractor to realize BCD to Excess–3 code conversion and vice versa. – L3
4. Design the Binary to Gray code converter and vice versa using logic gates. – L5
5. Construct the AND, OR, NOT, NAND, NOR, XOR and XNOR logic gates using MUX. – L3
6. Use the MUX and DEMUX chips to realize half and full adders, half and full subtractors and code converter respectively. – L3
7. Design the two bit comparator using logic gates and four bit comparator using 7485 chip. – L5
8. Use the decoder chip to drive LED display. – L3
9. Demonstrate the functionality of a Priority Encoder using 74147 chip. – L3
10. Verify the truth table for the Flip–Flops: (i) T type (ii) D type and iii) JK Master slave type. – L4
11. Design of 3 bit binary, decade and MOD – N counters using 7476, 7490, 74192/74193 chips respectively. – L5
12. Demonstrate the shift left, shift right, SIPO, SISO, PISO and PIPO operations using 7495. – L3
13. Test the Ring counter and Johnson counter operations using 7495. – L4