Ref No:

Sri Krishna Institute of Technology, Bengaluru-560090

COURSE PLAN

Academic Year - 2018-2019

Program:	B E –Electrical And Electronics Engineering
Semester :	4
Course Code:	18EE46
Course Title:	OPAMP AND LINEAR IC's
Credit / L-T-P:	4 / 4-0-0
Total Contact Hours:	60
Course Plan Author:	KIRANMAYI

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Note : Remove "Table of Content" before including in CP Book
Each Course Plan shall be printed and made into a book with cover page
Blooms Level in all sections match with A.2, only if you plan to teach / learn at higher levels

A. COURSE INFORMATION

1. Course Overview

Degree:	BE	Program:	EC
Semester:	4	Academic Year:	2018
Course Title:	OP AMP and LIC	Course Code:	18EE46
Credit / L-T-P:	4 / 4-0-0	SEE Duration:	180 Minutes
Total Contact Hours:	60 Hours	SEE Marks:	60 Marks
CIA Marks:	40 Marks	Assignment	1 / Module
Course Plan Author:	Kiranmayi	Sign ..	Dt:
Checked By:		Sign ..	Dt:
CO Targets	CIA Target : 54 %	SEE Target:	60. %

Note: Define CIA and SEE % targets based on previous performance.

2. Course Content

Content / Syllabus of the course as prescribed by University or designed by institute. Identify 2 concepts per module as in G.

Module	Content	Teaching Hours	Identified Module Concepts	Blooms Learning Levels
1	**Operational amplifiers**: Introduction, Block diagram representation of a typical Op-amp, schematic symbol, characteristics of an Op-amp, ideal op-amp, equivalent circuit, ideal voltage transfer curve,open loop configuration, differential amplifier, inverting & non –inverting amplifier, Op-amp with negative feedback(excluding derivations). **General Linear Applications:** A.C. amplifier, summing, scaling & averaging amplifier, inverting and non-inverting configuration, Instrumentation amplifier	10	OP-AMP Characteristics Linear and mathematical operations	L2, L4
2	**Active Filters:** First & Second order high pass & low pass Butterworth filters. Band pass filters,all pass filters. **DC Voltage Regulators:** voltage regulator basics, voltage follower regulator, adjustable output regulator, LM317 & LM337 Integrated circuits regulators.	16	Signal filterering Voltage Regulation	L4, L4
3	**Signal generators:** Triangular / rectangular wave generator, phase shift oscillator, saw tooth oscillator. **Comparators & Converters:** Basic comparator, zero crossing detector, inverting & non-inverting Schmitt trigger circuit, voltage to current converter with grounded load, current to voltage converter and basics of voltage to frequency and frequency to voltage converters	14	Signal Generation Comparison and conversion	L4, L4
4	**Signal processing circuits:** Precision half wave & full wave rectifiers **A/D & D/A Converters:** Basics, R–2R D/A Converter, Integrated circuit 8-bit D/A, successive approximation ADC, linear ramp ADC.	10	Rectification A/D and D/A Conversion	L4, L4
5	**Phase Locked Loop (PLL):** Basic PLL, components, performance factors. **Timer:** Internal architecture of 555 timer, Mono stable multi vibrators and applications.	10	Frequency and phase locking Pulse generation	L3, L4
-	**Total**	**60**	**-**	**-**

3. Course Material

Books & other material as recommended by university (A, B) and additional resources used by course teacher (C).

1. Understanding: Concept simulation / video ; one per concept ; to understand the concepts ; 15 – 30 minutes

2. Design: Simulation and design tools used – software tools used ; Free / open source
3. Research: Recent developments on the concepts – publications in journals; conferences etc.

Modules	Details	Chapters in book	Availability
A	**Text books (Title, Authors, Edition, Publisher, Year.)**	**-**	**-**
1,2	Op-Amps and Linear Integrated Circuits,Ramakant A Gayakwad, Pearson 4 th Edition 2015	1,2,3,6,7, 9,10	In Lib / In Dept
2,3,4,5	Operational Amplifiers and Linear ICs,David A. Bell,Oxford,3 rd Edition 2011	7,9,10,12,	In Lib/ In dept
B	**Reference books (Title, Authors, Edition, Publisher, Year.)**	**-**	**-**
1,2	Linear Integrated Circuits; Analysis,Design and Applications,B. Somanthan Nair, Wiley India,2013	5,8	In Lib
1,2,3,4, 5	Linear Integrated Circuits S. Salivahanan, et al McGraw Hill 2 nd Edition,2014.	3,4,5,6,7, 8,10,11	In Lib
3,4	Operational Amplifiers and Linear Integrated Circuits K. Lal Kishore Pearson 1 st Edition, 2012	4,8	In lib
C	**Concept Videos or Simulation for Understanding**	**-**	**-**
C1	OP-AMP Charecteristics https://www.youtube.com/watch?v=SaJsL9_M1_w&list=PLuv3GM6-gsE3npYPJJDnEF3pdiHZT6Kj3&index=16 - 36 min https://www.youtube.com/watch?v=tgMIX73SNPE&list=PLuv3GM6-gsE3npYPJJDnEF3pdiHZT6Kj3&index=17 -28 min		
C2	Linear and mathematical operations. https://www.youtube.com/watch?v=RSWsJjUqD2w&list=PLuv3GM6-gsE3npYPJJDnEF3pdiHZT6Kj3&index=49		
C3	Signal Filtering. https://www.youtube.com/watch?v=W70GFpflLKk&list=PLuv3GM6-gsE3npYPJJDnEF3pdiHZT6Kj3&index=24 https://www.youtube.com/watch?v=2e0--YSb2lo&list=PLuv3GM6-gsE3npYPJJDnEF3pdiHZT6Kj3&index=25 https://www.youtube.com/watch?v=uj4b2O4XVVE&list=PLuv3GM6-gsE3npYPJJDnEF3pdiHZT6Kj3&index=26 -33min		
C4	Voltage Regulation https://www.youtube.com/watch?v=5rRKmZs2lil		
C5	Signal Generation. https://www.youtube.com/watch?v=M3yl0byaqKc&list=PLuv3GM6-gsE3npYPJJDnEF3pdiHZT6Kj3&index=27 -43min https://www.youtube.com/watch?v=8eLolUGSXns&list=PLuv3GM6-gsE3npYPJJDnEF3pdiHZT6Kj3&index=28 -19 minimization https://www.youtube.com/watch?v=YH1zbPA_i2Y&list=PLuv3GM6-gsE3npYPJJDnEF3pdiHZT6Kj3&index=29 – 30 min		
C6	Camparision and conversion https://www.youtube.com/watch?v=V-bAduYluil&list=PLuv3GM6-gsE3npYPJJDnEF3pdiHZT6Kj3&index=50		
C7	Rectification https://nptel.ac.in/courses/108101091/46		
C8	A/D and D/A Convertion https://www.youtube.com/watch?v=kMGap-0XwGs https://www.youtube.com/watch?v=xdoAB7jevk0		
C9	Phase and frequency locking https://www.youtube.com/watch?v=9VNXLqFTqP4		
C10	Pulse Generation		

	https://www.youtube.com/watch?v=Rd3QSzye72w		
	Lab : https://www.youtube.com/watch?v=P9e7hUNPGVs -		
D	**Software Tools for Design**	**-**	**-**
CO1-CO10	Multisim		
E	**Recent Developments for Research**	**-**	**-**
CO3	High frequency operation - https://www.tandfonline.com/doi/abs/10.1080/00207219308925897		
CO4	Low drop out voltage with improved stability - https://patents.google.com/patent/US6373233B2/en		
CO5	Improved linearity-https://ieeexplore.ieee.org/abstract/document/4671125		
CO6	Improved timing accuracy -https://patents.google.com/patent/US6055287A/en		
CO7	Improved accuracy-https://ieeexplore.ieee.org/abstract/document/4303403		
CO8	High performance-https://ieeexplore.ieee.org/abstract/document/896237		
CO9	Improved power supply rejection - https://patents.google.com/patent/US6963233B2/en		
CO10	Reduced recovery time - https://digital-library.theiet.org/content/journals/10.1049/iet-cds_20060359		
F	**Others (Web, Video, Simulation, Notes etc.)**	**-**	**-**
1	Nptel online video lecture	Www.onlinecourses.nptel.ac.in	Nptel online video lecture

4. Course Prerequisites

Refer to GL01. If prerequisites are not taught earlier, GAP in curriculum needs to be addressed. Include in Remarks and implement in B.5.

Students must have learnt the following Courses / Topics with described Content . . .

Modules	Course Code	Course Name	Topic / Description	Sem	Remarks	Blooms Level
1	17ELN15 /25	Basic Electronics	1/ Semiconductor devices and BJT/ Fundamentals of diode characteristics and transistor characteristics	1/2		L2
2-5	17EE34	Analog Electronics Circuits	2/ Transistor biasing/ Knowledge of amplifiers and oscillators	3		L3

5. Content for Placement, Profession, HE and GATE

The content is not included in this course, but required to meet industry & profession requirements and help students for Placement, GATE, Higher Education, Entrepreneurship, etc. Identifying Area / Content requires experts consultation in the area.

Topics included are like, a. Advanced Topics, b. Recent Developments, c. Certificate Courses, d. Course Projects, e. New Software Tools, f. GATE Topics, g. NPTEL Videos, h. Swayam videos etc.

Modules	Topic / Description	Area	Remarks	Blooms Level
1	NPTEL Videos /Introduction Wafer Manufacturing Process and Clean room Protocols Introduction to Fabrication Process Technology and Op-amp	Higher Education/ GATE	Video lecturing by IISc professor on “Electronics Modules for Industrial Applications” and assignment questions.	Analyze L4

2	NPTEL Videos /Experiment: Op-amp based ECG Signal Acquisition, Conditioning and Processing for Computation of BPM	Higher Education/ GATE	Video lecturing by IISc professor on "Electronics Modules for Industrial Applications" and assignment questions.	Analyze L4
3	NPTEL Videos /Experiment: Op-amp based ECG Signal Acquisition, Conditioning and Processing for Computation of BPM	Higher Education/ GATE	Video lecturing by IISc professor on "Electronics Modules for Industrial Applications" and assignment questions.	Analyze L4
4	NPTEL Videos /Experiment: Op-amp based ECG Signal Acquisition, Conditioning and Processing for Computation of BPM	Higher Education/ GATE	Video lecturing by IISc professor on "Electronics Modules for Industrial Applications" and assignment questions.	Analyze L4
5	NPTEL Videos /Experiment: Op-amp based ECG Signal Acquisition, Conditioning and Processing for Computation of BPM	Higher Education/ GATE	Video lecturing by IISc professor on "Electronics Modules for Industrial Applications" and assignment questions.	Analyze L4

B. OBE PARAMETERS

1. Course Outcomes

Expected learning outcomes of the course, which will be mapped to POs. Identify a max of 2 Concepts per Module. Write 1 CO per Concept.

Modules	Course Code.#	Course Outcome **At the end of the course, student should be able to . . .**	Teach. Hours	Concept	Instr Method	Assessment Method	Blooms' Level
1	18EE46.1	Describe the characteristics of ideal and practical operational amplifier.	5	OP-AMP Charecteristics	Lecture	Unit Test and assignment	L2 Understand
1	18EE46.2	Design the linear applications of OP-AMP using IC LM741C .	5	Linear and mathematical operations.	Lecture	Unit Test and assignment	L4 Analyse
2	18EE46.3	Design filters using linear IC LM741C.	08	Signal Filtering.	Lecture	Unit Test and assignment	L4 Analyze
2	18EE46.4	Design DC Regulated power supply using regulators IC's LM317 and LM337.	08	Voltage Regulation	Lecture	Unit Test and assignment	L4 Analyse
3	18EE46.5	Design signal generators using linear IC LM741C.	7	Signal Generation.	Lecture	Unit Test and assignment	L4 Analyse
3	18EE46.6	Design the application of Linear ICs as comparators and Converter using IC LM741C.	08	Camparision and conversion	Lecture	Unit Test and assignment	L4 Analyse
4	18EE46.7	Design the application of Linear ICs as rectifiers using IC LM741C.	05	Rectification	Lecture	Unit Test and assignment	L4 Analyse
4	18EE46.8	Demonstrate the application of Linear ICs as A/D and D/A	05	A/D and D/A	Lecture /PPT	Unit Test and	L4 Analyse

		converter using IC LM741C.		Convertion		assignment	
5	18EE46.9	Demonstrate the application of Linear ICs as PLL using IC LM741C	05	Phase and frequency locking	Lecture /PPT	Unit Test and assignment	L3 understand
5	18EE46.10	Design the application of Linear ICs as Multivibrator using IC 555.	05	Pulse Generation	Lecture /PPT	Unit Test and assignment	L4 Analyse
-	**-**	**Total**	**61**	**-**	**-**	**-**	**L2-L4**

2. Course Applications

Write 1 or 2 applications per CO.
Students should be able to employ / apply the course learnings to . . .

Modules	Application Area Compiled from Module Applications.	CO	Level
1	Apply in designing electronic circuits.	CO1	L2
1	Summing amplifier is Used in audio mixer to add different signals with n equal gains. Instrumentaion amplifiers are used in data acquisition systems.	CO2	L4
2	Active filters are used in communication systems for suppressing noise, in audio systems , biomedical instruments to interface psychological sensors with diagnostic equipments and data logging.	CO3	L4
2	Regulators are used in developing regulated DC power supply.	CO4	L4
3	Signal generator is used in industry, agriculture, boimedicine and other fields such as high frequency induction heating, melting , quenching, ultrasonic diagnosis, nuclear magnetic resonance imaging etc..	CO5	L4
3	Comparators are used in oscillators, DAC, ADC , multi-vibrators and etc	CO6	L4
4	Rectifiers are used in DC regulated power supply.	CO7	L4
4	DAC and ADC are used in data acquition system.	CO8	L4
5	PLL is used in motor speed control and tracking filter.	CO9	L3
5	Multivibrators are used in delay , timing circuits , frequency dividers and to generate clock pulses for computer.	CO10	L4

3. Mapping And Justification

CO – PO Mapping with mapping Level along with justification for each CO-PO pair.
To attain competency required (as defined in POs) in a specified area and the knowledge & ability required to accomplish it.

Modules	Mapping		Mapping Level	Justification for each CO-PO pair	Level
-	**CO**	**PO**	**-**	**'Area': 'Competency' and 'Knowledge' for specified 'Accomplishment'**	**-**
1	CO1	PO2	2	Analysis of output of electronic circuits using op amp requires knowledge of op amp characteristics.	L3
1	CO2	PO1	2	Knowledge of linear applications such as adder,summer,AC and DC amplifier using op amp is required in understanding the working of complex electronic circuits.	L1
1	CO2	PO2	2	Analysis of complex electronic circuits needs knowledge of Op amp linear applications.	L3
1	CO2	PO3	2	Design of linear applications such as adder,summer,AC and DC amplifier using op amp are used in many instrumentation amplifier	L4
1	CO2	PO11	2	The Design knowledge of linear applications of Op Amp can be used in electronic-projects.	L4
2	CO3	PO1	2	Knowledge of filters using op amp is required in understanding the working of complex electronic circuits.	L1
2	CO3	PO2	2	Analysis of complex electronic circuits needs knowledge of filters using op amp.	L3
2	CO3	PO3	2	Design of filters using op amp are used usually part of communication	L4

				systems.	
2	CO3	PO11	2	The Design knowledge of filters using Op Amp can be used in electronic-projects.	L4
2	CO4	PO1	2	Knowledge of regulators using op amp is required in a designing of DC power supply.	L1
2	CO4	PO2	2	Analysis of DC power supply needs knowledgeof regulator using op amp.	L3
2	CO4	PO3	2	Design of regulator using op amp is a part of DC power supply design.	L4
2	CO4	PO11	2	The Design of DC power supply is used in developing a power supply system for projects.	L4
3	CO5	PO1	2	Knowledge of signal generator using op amp is required in a designing of complex electronics circuits.	L1
3	CO5	PO2	2	Analysis of complex electronics circuits may need knowledge of signal generator using op amp.	L3
3	CO5	PO3	2	Design of signal generator using op amp is a part of complex electronic circuits design.	L4
3	CO5	PO11	2	The Design of signal generator using op amp may be used in projects.	L4
3	CO6	PO1	2	Knowledge of comparator and converter using op amp is required in a designing of complex electronics circuits.	L1
3	CO6	PO2	2	Analysis of complex electronics circuits may need knowledge of using comparator and converter using op amp.	L3
3	CO6	PO3	2	Design of comparator and converter using op amp is a part of complex electronic circuits design.	L4
3	CO6	PO11	2	The Design of comparator and converter using op amp will be used in projects.	L4
4	CO7	PO1	2	Knowledge of rectification using op amp is required in a designing of DC regulated power supply.	L1
4	CO7	PO2	2	Analysis of DC regulated power supply need knowledge of rectification using op amp.	L3
4	CO7	PO3	2	Design of rectifier using op amp is a part of DC regulated power supply design.	L4
4	CO7	PO11	2	The Design of rectifier using op amp will be used in projects.	L4
4	CO8	PO1	2	Knowledge of A/D and D/A conversion using op amp is required in a designing of Data acquisition systems.	L1
4	CO8	PO2	2	Analysis of Data acquisition system need knowledge of A/D and D/A conversion using op amp.	L3
4	CO8	PO11	2	Knowledgeof A/D and D/A conversion using op amp will be applied in projects.	L4
5	CO9	PO1	2	Knowledge of phase ans frequency locking using op amp is required normally in RF based applications and in motor speed control.	L1
5	CO9	PO2	2	Analysis of RF based applications need knowledge of phase ans frequency locking using op amp.	L3
5	CO9	PO11	2	Knowledge of phase locked loop using op amp will be applied in projects.	L4
5	CO10	PO1	2	Knowledge of pulse generation using 555 timer is required in delay and timing circuits such as clock pulse generation.	L1
5	CO10	PO2	2	Analysis of delay and timing circuits need knowledge of pulse generation using 555 timer.	L3
5	CO10	PO3	2	Design of multi-vibrator using 555 timer can be a part of compex application design.	L4
5	CO10	PO11	2	Knowledge of pulse generation using 555 timer will be applied in projects.	L4

4. Articulation Matrix

CO – PO Mapping with mapping level for each CO-PO pair, with course average attainment.

-	-	Course Outcomes	Program Outcomes															-
Modules	CO.#	**At the end of the course student should be able to . . .**	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO1	PSO2	PSO3	Level

1	18EE46.1	Describe the characteristics of ideal and practical operational amplifier.	**2**	**2**									**2**					L2
1	18EE46.2	Design the linear applications of OP-AMP using IC LM741C .	**2**	**2**	**2**								**2**					L4
2	18EE46.3	Design filters using linear IC LM741C.	**2**	**2**	**2**								**2**					L4
2	18EE46.4	Design DC Regulated power supply using regulators IC's LM317 and LM337.	**2**	**2**	**2**								**2**					L4
3	18EE46.5	Design signal generators using linear IC LM741C.	**2**	**2**	**2**								**2**					L4
3	18EE46.6	Design the application of Linear ICs as comparators and Converter using IC LM741C.	**2**	**2**	**2**								**2**					L4
4	18EE46.7	Design the application of Linear ICs as rectifiers using IC LM741C.	**2**	**2**	**2**								**2**					L4
4	18EE46.8	Understand the application of Linear ICs as A/D and D/A converter using IC LM741C.	**2**	**2**									**2**					L4
5	18EE46.9	Understand the working of PLL using IC LM741C and its applications.	**2**	**2**									**2**					L3
5	18EE46.10	Design of multivibrator using IC 555 timer and its applications.	**2**	**2**	**2**								**2**					**L4**
-	**CS501PC**	**Average attainment (1, 2, or 3)**																**-**
-	*PO, PSO*	*1.Engineering Knowledge; 2.Problem Analysis; 3.Design / Development of Solutions; 4.Conduct Investigations of Complex Problems; 5.Modern Tool Usage; 6.The Engineer and Society; 7.Environment and Sustainability; 8.Ethics; 9.Individual and Teamwork; 10.Communication; 11.Project Management and Finance; 12.Life-long Learning; S1.Software Engineering; S2.Data Base Management; S3.Web Design*																

5. Curricular Gap and Content

Topics & contents not covered (from A.4), but essential for the course to address POs and PSOs.

Modules	Gap Topic	Actions Planned	Schedule Planned	Resources Person	PO Mapping
1	Photolithography (Heart of Microengineering Process)	Placement, GATE, Higher Study.	Video session	14th Feb 2019	Dr Hardik Pandey, IISc Professor

6. Content Beyond Syllabus

Topics & contents required (from A.5) not addressed, but help students for Placement, GATE, Higher Education, Entrepreneurship, etc.

Modules	Gap Topic	Area	Actions Planned	Schedule Planned	Resources Person	PO Mapping
1	Photolithography (Heart of Microengineering Process)	Placement, GATE, Higher Study.	Video session	14th Feb 2019	Dr Hardik Pandey, IISc Professor	3

C. COURSE ASSESSMENT

1. Course Coverage

Assessment of learning outcomes for Internal and end semester evaluation. Distinct assignment for each student. 1 Assignment per chapter per student. 1 seminar per test per student.

Modules	Title	Teach. Hours	No. of question in Exam						CO	Levels
			CIA-1	CIA-2	CIA-3	Asg	Extra	SEE		

							Asg			
1	Operational amplifiers and General Linear Applications	10	2	-	-	1	1	2	CO1, CO2	L2, L4
2	Active Filters and DC Voltage Regulators	16	2	-	-	1	1	2	CO3, CO4	L4, L4
3	Signal generators and Comparators & Converters	15	-	2	-	1	1	2	CO5, CO6	L4, L4
4	Signal processing circuits and A/D & D/A Converters	10	-	2	-	1	1	2	CO7, Co8	L4, L4
5	Phase Locked Loop (PLL) and Timer	10	-	-	4	1	1	2	CO9, CO10	L3 L4
-	**Total**	**60**	**4**	**4**	**4**	**5**	**5**	**10**	**-**	**-**

2. Continuous Internal Assessment (CIA)

Assessment of learning outcomes for Internal exams. Blooms Level in last column shall match with A.2.

Modules	Evaluation	Weightage in Marks	CO	Levels
1, 2	CIA Exam – 1	30	CO1, CO2, CO3, CO4	L2, L4, L4, L4
3, 4	CIA Exam – 2	30	CO5, CO6, CO7, Co8	L4, L4, L4, L4
5	CIA Exam – 3	30	CO9, CO10	L3, L4
1, 2	Assignment - 1	10	CO1, CO2, CO3, CO4	L2, L4, L4, L4
3, 4	Assignment - 2	10	CO5, CO6, CO7, CO8	L4, L4, L4, L4
5	Assignment - 3	10	CO9, CO10	L3, L4
1, 2	Seminar - 1		-	-
3, 4	Seminar - 2		-	-
5	Seminar - 3		-	-
1, 2	Quiz - 1		-	-
3, 4	Quiz - 2		-	-
5	Quiz - 3		-	-
1 - 5	Other Activities – Mini Project	-	CO9, CO10	L2,L2
	Final CIA Marks	**20**	**-**	**-**

D1. TEACHING PLAN - 1

Module - 1

Title:	Operational Amplifiers and General Linear Application	Appr Time:	10 Hrs
a	***Course Outcomes***	-	**Blooms**
-	The student should be able to:	-	**Level**
1	Describe the characteristics of ideal and practical operational amplifier.	CO1	L2
2	Design the linear applications of OP-AMP using IC LM741C .	CO2	L4
b	***Course Schedule***	-	-
Class No	**Module Content Covered**	**CO**	**Level**
1	Introduction, Block diagram representation of a typical Op-amp.	C01	L2
2	schematic symbol, characteristics of an Op-amp	C01	L2
3	ideal op-amp, equivalent circuit, ideal voltage transfer curve	C01	L2
4	open loop configuration, differential amplifier, inverting & non –inverting amplifier	C01	L2
5	Op-amp with negative feedback(excluding derivations)	C01	L2
6	A.C. amplifier.	C02	L2
7	summing, scaling & averaging amplifier using inverting and non-inverting configuration	C02	L4
8	summing, scaling & averaging amplifier using non-inverting configuration	C02	L4

9	Instrumentation amplifier	Co2	L2
10	Instrumentation amplifier	Co2	L2
c	**Application Areas**	**CO**	**Level**
1	Use in designing electronic circuits.	CO1	L2
2	Summing amplifier is Used in audio mixer to add different signals with n equal gains. Instrumentaion amplifiers are used in data acquisition systems.	CO2	L4
d	**Review Questions**	-	-
1	Define the following electrical parameters: input offset voltage, input resistance, CMRR, output voltage swing and slew rate.	CO1	L2
2	What are the characteristics of of an ideal op amp?	CO1	L2
3	What is the voltage transfer curve of an op amp?	CO1	L2
4	List 3 open loop op amp configurations.	CO1	L1
5	Explain why open loop op amp configurations are not used in linear applications.	CO1	L2
6	State the typical values of input offset voltage, CMRR, slew rate and PSRR for IC 741 op amp.	CO1	L1
7	Define input offset voltage and explain why it exists in all op amps.	CO1	L2
8	Why is it necessary to use an external offset voltage compensating network with practical op amp circuits?	CO1	L2
9	What is the offset minimizing resistor Rom ?	CO1	L2
10	Why is the output offset voltage generated by the input bias current always larger than generated by the input offset current?	CO1	L2
11	What are the factors that affect the input offset voltage, input bias and input offset currents?	CO1	L1
12	What is thermal drift ? How does it affect performance of an op amp circuit?	CO1	L2
13	Briefly explain the difference between the dc and ac amplifiers.	CO2	L2
	What are the major advantage and disadvantage of a single supply ac amplifiers?	CO2	L2
	Explain the concept of virtual ground in context with an op amp.	CO2	L2
14	State the advantages of negative feedback.	CO2	L1
	What is an instrumentation amplifier? List three application of instrumentation amplifier.	CO2	L2
e	**Experiences**	-	-
1		CO1	L2
2			
3			
4		CO3	L3
5			
5			

Module – 2

Title:	Active filters and DC Voltage Regulator	Appr Time:	16 Hrs
a	***Course Outcomes***	-	**Blooms**
-	The student should be able to:	-	**Level**
1	Design filters using linear IC LM741C.	CO3	L4
2	Design DC Regulated power supply using regulators IC's LM317 and LM337.	CO4	L4
b		-	-
Class No	**Module Content Covered**	**CO**	**Level**
11	Introduction to filters. Difference between active and passive filters	CO3	L4
12	First order low pass Butterworth filters	CO3	L3

13	First order high pass Butterworth filters	CO3	L3
14	Second order low pass Butterworth filters	CO3	L3
15	Second order high pass Butterworth filters	CO3	L3
16	Band pass filters – wide band pass	CO3	L3
17	Band pass filters – narrow band pass	CO3	L4
18	all pass filters	CO3	L2
19	voltage regulator basics	CO4	L2
20	voltage regulator basics	CO4	L2
21	voltage follower regulator	CO4	L3
22	voltage follower regulator	CO4	L4
23	adjustable output regulators	CO4	L4
24	adjustable output regulators	CO4	L2
25	LM317 & LM337 Integrated circuits regulators.	CO4	L2
26	LM317 & LM337 Integrated circuits regulators.		
c	**Application Areas**	**CO**	**Level**
1	Active filters are used in communication systems for suppressing noise, in audio systems , biomedical instruments to interface psychollogical sensors with diagnostic equipments and data logging.	CO5	L4
2	Regulators are used in developing regulated DC power supply.	CO6	L4
d	**Review Questions**	-	-
1	Define a filter. How are filters classified?	CO3	L1
2	What is a passband and a stopband for a filter?	CO3	L1
3	What are the advantages of active filters over passive ones?	CO3	L2
4	What is Butterworth response?	CO3	L1
5	What is an all -pass filter? Where and why is it needed?	CO3	L1
6	What is a voltage regulator?	CO4	L1
7	Briefly explain the action of a DC voltage regulators.	CO4	L2
8	Write the equations for line regulation, load regulation and ripple rejection.	CO4	L2
9	What are the advantages of adjustable voltage regulators over the fixed voltage regulator?	CO4	L2
10	What are the blocks of DC power supply?	CO4	L1
e	**Experiences**	-	-
1		CO1	L2
2			
3			
4		CO3	L3
5			

E1. CIA EXAM – 1

a. Model Question Paper - 1

Crs Code:	18EE46	Sem:	4	Marks:	30	Time:	75 minutes
Course:	OP Amp and Linear Integrated						

-	-	**Note: Answer any 3 questions, each carry equal marks:1,2**	**Marks**	**CO**	**Level**
1	a	With a neat block diagram , explain the general stages of an OP-AMP IC.	5	CO1	L2
	b	Explain the effect of feedback on input resistance, output resistance of a practical non inverting amplifier.	5	CO1	L3
	c	The 741C OP-AMP having the following parameters is connected as a inverting amplifier with R_1 =470Ω and R_F =4.7KΩ . A= 200,000, R_i = 2MΩ, R_o = 75Ω, f_o = 5HZ .Supply voltages = ±15V and output voltage swing = ±13V. Calculate A_F, R_{iF}, R_{oF} and f_F.	5	CO1	L4
		OR			
2	a	Derive an expression for output voltage of differential summing amplifier	5	CO2	L3
	b	Derive the closed loop voltage gain of voltage series feedback amplifier	5	CO2	L3
	c	What is an instrumentation amplifier? For instrumentation amplifier using	5	CO2	L2

		transducer bridge obtain an expression for output voltage Vo in terms of change in resistance ΔR of the transducer. Draw the circuit diagram			
3	a	Derive the expression for gain and phase angle of first order low pass butterworth filter.	5	CO3	L3
	b	Explain the following performance parameters of voltage regulator.I) Line Regulation. ii) Load Regulation iii) Ripple Rejection.	5	CO4	L2
	c	Design a high pass filter with a cut-off frequency of 10KHZ with a passband gain of 1.5	5	CO3	L4
		OR			
4	a	With a neat circuit diagram, explain the operation of a adjustable regulator using OP – AMP.	5	CO4	L2
	b	Explain in detail the all pass filter and mention applications.	5	CO3	L2
	c	An LM317 regulator is to provide 6v output from 15V supply. The load current is 200mA. Design the circuit, calculate the power dissipation. Draw the circuit diagram. Select I1 = 1mA, Vref – 1.25V.	5	CO4	L4
2	a	Describe the Z parameters in reciprocal networks?	5	CO3	L2
	b	Derive an expression for standing wave ratio and explain?	10	CO2	L3

b. Assignment -1

Note: A distinct assignment to be assigned to each student.

Model Assignment Questions

Crs Code:	18EE46	Sem:	I	Marks:	5 / 10	Time:	90 – 120 minutes
Course:	OP Amp and Linear Integrated						

Note: Each student to answer 2-3 assignments. Each assignment carries equal mark.

SNo	USN	Assignment Description	Marks	CO	Level
1	1KT16EE002	With a neat block diagram, explain the general stages of an op amp IC.	5	CO1	L2
2	1KT16EE010	Derive the closed loop voltage gain of voltage series feedback amplifier.	5	CO1	L3
3	1KT16EE024	Derive the closed loop voltage gain of voltage shunt feedback amplifier.	4	CO1	L3
4	1KT17EE002	Explain the effect of feedback on input resistance, output resistance of a practical non inverting amplifier.	5	CO1	L3
	1KT17EE003	Explain the effect of feedback on input resistance, output resistance of a practical inverting amplifier.	5	CO1	L3
5	1KT17EE004	Define and explain the following terms:input offset voltage, input offset current and input bias current.	5	CO1	L2
6	1KT17EE006	For the non inverting amplifier configuration, obtain expressions for closed loop gain. Af from the basic concepts, show that difference input voltage is zero ideally and hence gain Af from this concept and input resistance Rif with feedback.	5	CO1	L3
8	1KT17EE007	In the circuit of AC inverting amplifier Rin = 50ohm, Ci = 0.1f, R1 = 100ohm, Rf = 1Kohm and supply voltages = 15V.Determine the bandwidth of the amplifier(UGB = 106, K = 0.909 for 741IC)	5	CO1	L3
9	1KT17EE008	For the non inverting ac amplifier single supply Ria = 50ohm = Ro, Ci = C1 = 0.1f, R1 = R2 = R3 = 100Kohm, Rf = 1Mohm, VCC = +15V, gain Af = 11, UGB = 1MHZ.Calculate bandwidth of amplifier and maximum output voltage swing. Draw the circuit diagram.	5	CO1	L3
10	1KT17EE010	The IC 741C op amp having the following parameters is connected as a inverting amplifier with R1 = 470 and Rf = 4.7K. A = 200,000, Ri = 2M, Ro = , fo = 5HZ.Supply voltages = 15V and output voltage swing = 13v.Calculate Af, Rif, Rof and fF.	2	C01	L3
11	1KT17EE011	Derive an expression for the output of a inverting summing amplifier with three inputs and averaging amplifier.	5	CO2	L3
12	1KT17EE014	Derive an expression for output voltage of differential summing amplifier.	5	CO2	L4

13	1KT17EE015	Draw and explain the operation of peaking amplifier	5	CO2	L2
14	1KT16EE015	What is an instrumentation amplifier? For instrumentation amplifier using transducer bridge obtain an expression for output voltage Vo in terms of change in resistance ΔR of the transducer. Draw the circuit diagram	5	CO2	L2
15	1KT18EE400	The circuit of peaking amplifier is to provide a gain of 10 at a peak frequency of 16KHZ.Determine the values of all components.	5	CO2	L3
16	1KT18EE401	Derive the expression for gain and phase angle of first order low pass Butterworth filter and draw its frequency response.	5	CO3	L3
17	1KT16EE002	Derive the expression for gain and phase angle of first order high pass Butter worth filter and draw its frequency response.	5	CO3	L3
18	1KT16EE010	Design a low pass filter at a cut off frequency of 15.9KHZ with a passband gain 1.5.	5	CO3	L4
19	1KT16EE024	Sketch the circuit of second order active low pass filter. Explain its operation with the expected frequency response and indicate the design steps.	5	CO3	L2
20	1KT17EE002	Sketch the circuit of second order active High pass filter. Explain its operation with the expected frequency response and indicate the design steps.	5	CO3	L2
21	1KT17EE003	Using op amp , design a second order low pass filter with a cut off frequency of 1KHZ.	5	CO3	L4
22	1KT17EE004	Design a Butterworth Second – order high pass filter circuit to have a cut off frequency of 6KHZ. Calculate the actual cut frequency for the circuit using the selected component values.C1 = 1000pF, C2 = C1 = 1000PF.	5	CO3	L4
23	1KT17EE006	What is a band pass filter? Sketch the circuit of a single stage band pass filter. Explain the low pass and high pass of the circuit. Discuss the design.	5	CO3	L2
24	1KT17EE007	Design a wide band pass filter with fL = 200HZ, fH = 1KHZ and pass band gain = 4. Assume capacitor value for high pass section = 0.05microF and for low pass section = 0.01microF.Also calculate the value of Q factor for the filter and center frequency. Draw the circuit diagram.	5	CO3	L4
25	1KT17EE008	Design a single stage band pass filter with unity gain and a pass band from 300HZ to 30KHZ.	5	CO3	L4
26	1KT17EE010	Explain the terms – figure of merit, centre frequency and band width with respect to band pass filter.	5	CO3	L2
27	1KT17EE011	Explain with a block diagram and response curve, how Band stop filter can be obtained using low pass, high pass and summing circuit.	5	CO3	L2
28	1KT17EE014	Design a wide band reject filter using first order high pass and low pass filters having fL = 2KHZ and fH = 400HZ respectively with pass band gain as 2.	5	CO3	L4
29	1KT17EE015	Design the narrow band pass filter with two feedback paths with fC = 1.5khz, Q = 7 and AF = 15.Calculate the new value of resistance in the circuit which will change fc to 2khz.	5	CO3	L4
30	1KT16EE015	Explain the working of notch filter. Draw its frequency response. State its common application.	5	CO3	L2
31	1KT18EE400	Design a notch filter to eliminate 120HZ hum.	5	CO3	L4
32	1KT18EE401	Explain in detail the all pass filter and mention applications.	5	CO3	L2
33	1KT16EE002	Explain the following performance parameters of voltage regulator. i) Line Regulation. ii) Load Regulation iii) Ripple Rejection.	5	CO4	L2
34	1KT16EE010	Draw and explain the block schematic of regulated power supply.	5	CO4	L2
35	1KT16EE024	With a neat circuit diagram, explain the operation of a voltage	5	CO4	L2

		follower regulator using OP – AMP.			
36	1KT17EE002	Derive the expressions for the performance parameters of voltage follower regulator.	5	CO4	L3
37	1KT17EE003	Design a voltage follower regulator to provide output voltage of approximately 6V.The load resistance has a minimum value of 150Ω and the available supply voltage is ±12V.Use 1N753 zenior diode has Vz = 6.3V and Iz = 20mA.	5	CO4	L4
38	1KT17EE004	The voltage follower regulator has Vs = Vcc = 12V, Vo = 6.3v, R1 = 270Ω. D1 is a IN753 Zener diode and IL(max) = 42mA.If the supply source resistance is 25Ω, determine the line regulation, load regulation and ripple rejection for the circuit.(Zz = 7ohm from IN753 data sheet)	5	CO4	L3
39	1KT17EE006	Design a voltage follower regulator circuit using 741 opamp with following specifications: 1) output voltage 12V 2) Maximum load current = 50mA.	5	CO4	L4
40	1KT17EE007	With a neat circuit diagram, explain the operation of a adjustable regulator using OP – AMP.	5	CO4	L2
41	1KT17EE008	Briefly explain with the help of schematic diagram, the working of LM317 IC regulator.	5	CO4	L2
42	1KT17EE010	Calculate the resistance of R1 and R2 for the LM317 voltage regulator to produce an output voltage of 9v.	5	CO4	L3
43	1KT17EE011	An LM317 regulator is to provide 6v output from 15V supply. The load current is 200mA. Design the circuit, calculate the power dissipation. Draw the circuit diagram. Select I1 = 1mA, Vref – 1.25V.	5	CO4	L3

D2. TEACHING PLAN - 2

Module – 3

Title:	Signal Generators and comparator	Appr Time:	15 Hrs
a	***Course Outcomes***	-	**Blooms**
-	The student should be able to:	-	**Level**
1	Design signal generators using linear IC LM741C.	CO5	L4
2	Design the application of Linear ICs as comparators and Converter using IC LM741C.	CO6	L4
b	***Course Schedule***		
Class No	**Module Content Covered**	**CO**	**Level**
27	Triangular / rectangular wave generator.	CO5	L4
28	Problems on Triangular / rectangular wave generator	CO5	L3
29	phase shift oscillator	CO5	L2
30	Problems on phase shift oscillator	CO5	L3
31	saw tooth oscillator	CO5	L3
32	Basic comparator, zero crossing detector	CO6	L2
33	Basics of Schmitt trigger circuit	CO6	L2
34	Inverting Schmitt trigger circuit	CO6	L2
35	Problems on inverting Schmitt trigger circuit	CO6	L4
36	Non-inverting Schmitt trigger circuit	CO6	L2
37	Problems on Non-inverting Schmitt trigger circuit	CO6	L4
38	voltage to current converter with grounded load	CO6	L3
39	current to voltage converter	CO6	L3
40	Basics of voltage to frequency and frequency to voltage converters.	CO6	L2
41	Basics of voltage to frequency and frequency to voltage converters.	CO6	L2
c	**Application Areas**	**CO**	**Level**
1	Signal generator is used in industry, agriculture, biomedicine and other fields	CO1	L3

	such as high frequency induction heating, melting , quenching, ultrasonic diagnosis, nuclear magnetic resonance imaging etc..		
2	Comparators are used in oscillators, DAC, ADC , multi-vibrators and etc	CO2	L4
d	**Review Questions**	-	-
1	Define an oscillator.	CO5	L2
2	What are the two requirements for oscillation?	CO5	L2
3	How are oscillators are classified?	CO5	L2
4	What is frequency stability? Explain its significance.	CO5	L2
5	What is the difference between the sawtooth wave and the triangular wave?	CO5	L2
6	What is a comparator?	CO5	L2
7	What is the basic difference between basic comparator and schmitt trigger?	CO5	L2
8	List the important characteristics of the comparator?	CO5	L2
9	What is a voltage limit, and why is it needed?	CO6	L2
10	Name and then briefly describe the one application of V/F and F/V converters.	CO6	L2
e	**Experiences**	-	-
1		CO1	L2
2			
3			
4		CO3	L3
5			
4		CO6	L3
5			

Module – 4

Title:	Signal processing circuits and A/D & D/A Converters	Appr Time:	10 Hrs
a	***Course Outcomes***	-	**Blooms**
-		-	**Level**
1	Design the application of Linear ICs as rectifiers using IC LM741C.	CO7	L4
2	Demonstrate the application of Linear ICs as A/D and D/A converter using IC LM741C.	CO8	L3
b			
Class No	**Module Content Covered**	**CO**	**Level**
42	Signal processing circuits: Precision half wave rectifiers : saturating and non saturating half wave rectifiers	CO7	L2
43	Precision Half wave rectifiers: Two output precision rectifier, negative precision rectifier	CO7	L2
44	Precision full wave rectifiers:1)Using haif wave rectifier and summing circuit	CO7	L2
45	Precision full wave rectifiers:2) High input impedance full wave precision rectifier.	CO7	L2
46	Design problems on rectifiers	CO7	L4
47	A/D & D/A Converters:Basics	CO8	L2
48	R–2R D/A Converter	CO8	L2
49	Integrated circuit 8-bit D/A	CO8	L2
50	Successive approximation ADC	CO8	L2
51	linear ramp ADC	CO8	L2
c	**Application Areas**	**CO**	**Level**
1	Rectifiers are used in DC regulated power supply.	CO7	L3
2	DAC and ADC are used in data acquition system.	CO8	L4
d	**Review Questions**	-	-
1	What is precision rectifier?state its advantages	CO7	L2

2	Sketch the circuit of a saturating type half wave precision rectifier. Draw the input and output waveforms and explain the circuit operation	CO7	L2
3	Discuss the advantages of a precision rectifier over an ordinary diode circuit and show how the voltage gain can be achieved with a saturating precision rectifier.	CO7	L2
4	Sketch the circuit of a non saturating type half wave precision rectifier. Draw the input and output waveforms and explain the circuit operation, and discuss its advantages over the saturating type circuit.	CO7	L2
5	Sketch the circuit of a two output half wave precision rectifier. Draw the input and output waveforms and explain the circuit operation	CO7	L2
6	What is difference between A/D and D/A converters.	CO8	L4
7	Define the following terms for D/A converters : resolution, settling time, conversion time.	CO8	L2
8	State electrical characteristics of IC 1408	CO8	L2
9	What do you mean by quantization error?	CO8	L2
10	Explain the advantages of R/2R ladder technique over binary weighted resistor technique.	CO8	L2
e	**Experiences**	-	-
1		CO7	L2
2			
3			
4		CO8	L3
5			

E2. CIA EXAM – 2

a. Model Question Paper - 2

Crs Code:	18EE46	Sem:	4	Marks:	30	Time:	75 minutes
Course:	OP Amp and Linear Integrated						

-	-	**Note: Answer any 2 questions, each carry equal marks.**	**Marks**	**CO**	**Level**
1	a	Sketch the circuit of triangular/rectangular waveform generator. Draw the output waveforms from the circuit and explain its operation.	10	CO5	L2
	b	Design a RC phase shift oscillator for an output waveform frequency of 5KHZ.Use LM741 with ±15v power supply.	5	CO5	L4
		OR			
2	a	Explain the working of Wien bridge oscillator with the help of circuit diagram, waveform and equations.	5	CO5	L2
	b	With a neat circuit diagram and waveforms. Explain the operation of inverting schmittrigger with different LTP and UTP. Draw its hysteresis curve.	5	CO6	L2
	c	Design a Wein bridge oscillator to have an output frequency of 15KHZ using a BIFET opamp with a supply voltage of ±12V.Assume C1 = C2 = C = 0.01µF.	5	CO5	L4
3	a	With a neat circuit diagram, show how a half wave precision rectifier can be combined with a summing circuit to produce a full wave precision rectifier. Draw the voltage waveform at relevant stages of the circuit and write the equations to show that full wave rectification is proffered.	6	CO7	L2
	b	Define the following terms for D/A converters : resolution, settling time, conversion time, accuracy.	4	CO8	L2
	c	Design a non inverting schmitt trigger circuit to have UTP = +3V and LTP = -5V.Use a 741 op-amp with VCC = ±15V.	5	CO6	L4
		OR			
4	a	Explain R/2R ladder technique of D/A converter.	6	CO8	L2
	b	An 8-bit DAC has resolution of 20mv/LSB. Find Vofs and Vo if the inputs are 10000000 and 10000110.	3	CO8	L3
	c	Explain the successive approximation analog to digital converter technique with the help of a block diagram and an example.	6	CO8	L2

		OR			
2	a	Extract the field pattern for the ordinary linear end fire array of n isotropic point sources of equal amplitude and spacing	7	CO7	L3
	b	Prove that the radiation resistance of a thin linear antenna is 75 ohm	8	CO8	L4

b. Assignment – 2

Note: A distinct assignment to be assigned to each student.

Model Assignment Questions							
Crs Code:	18EE46	Sem:	4	Marks:	5 / 10	Time:	90 – 120 minutes
Course:	OP AMP and Linear Integrated Circuits.						
Note: Each student to answer 2-3 assignments. Each assignment carries equal mark.							

SNo	USN	Assignment Description	Marks	CO	Level
1	1KT16EE002	State the Barkausen criteriaon and explain how it is fulfilled in RC phase shift oscillator.Draw the waveforms at various points and explain its operation.	5	CO5	L2
2	1KT16EE010	Sketch the circuit of triangular/rectangular waveform generator. Draw the output waveforms from the circuit and explain its operation.	5	CO5	L2
3	1KT16EE024	Explain the diode amplitude stabilization of RC phase shift oscillator with diagram and equations.	5	CO5	L2
4	1KT17EE002	Design the phase shift oscillator of fig below to give a maximum output of ±3v with oscillation of 6KHZ.Include distortion minimization adjustement.	5	CO5	L4
5	1KT17EE003	Design a RC phase shift oscillator for an output waveform frequency of 5KHZ.Use LM741 with ±15v power supply.	5	CO5	L4
6	1KT17EE004	Design a RC phase shift oscillator using opamp.Assume C = 0.1μF frequency of oscillations = 200HZ.Draw the circuit diagram.	5	CO5	L4
7	1KT17EE006	Explain the working of Wien bridge oscillator with the help of circuit diagram, waveforms and equations.	5	CO5	L2
8	1KT17EE007	Design a Wein bridge oscillator to have an output frequency of 15KHZ using a BIFET opamp with a supply voltage of ±12V.	5	CO5	L4
	1KT17EE008	Design a Wein bridge oscillator to have an output frequency of 15KHZ using a BIFET opamp with a supply voltage of ±12V.Assume C1 = C2 = C = 0.01μF.	5	CO5	L4
6	1KT17EE010	Explain the working of voltage to current with grounded load.	5	CO6	L2
7	1KT17EE011	Explain the circuit of non inverting comparator. Draw the different waveforms when Vref is positive and negative.	5	CO6	L2
8	1KT17EE014	Explain the circuit of inverting comparator. Draw the different waveforms when Vref is positive and negative.	5	CO6	L2
9	1KT17EE015	Advantages of schmittrigger over zero crossing detector.	5	CO6	L4
10	1KT16EE015	With a neat circuit diagram and waveforms. Explain the operation of inverting schmittrigger with different LTP and UTP. Draw its hysteresis curve.	5	CO6	L2
11	1KT18EE400	Design a non inverting schmitt trigger circuit to have UTP = +3V and LTP = -5V.Use a 741 opamp with VCC = ±15V.	5	CO6	L4
12	1KT18EE401	Draw the circuit of a non saturating type half wave precision rectifier. Draw the input and output waveforms and explain the circuit operation.	5	CO7	L2
13	1KT16EE002	Draw the circuit of full wave precision rectifier. Draw the input and output waveforms and explain the circuit operation.	5	CO7	L2
14	1KT16EE010	List the the advantages of a precision rectifier over an ordinary diode circuit.	4	CO7	L4
15	1KT16EE024	With a neat circuit diagram, show how a half wave precision rectifier can be combined with a summing circuit to produce a full wave precision rectifier. Draw the voltage waveforms at relevant stages of the circuit and write the equations to show that full wave rectification is preffered.	8	CO7	L2
16	1KT17EE002	With a neat diagram, explain the operation of high input	8	CO7	L2

		impedance full wave precision rectifier. Draw the waveforms at various point. Write the equations to show that full wave rectification is performed.			
17	1KT17EE003	Define the following terms for D/A converters : resolution, settling time, conversion time, accuracy.	4	CO8	L2
18	1KT17EE004	An 8-bit DAC has resolution of 20mv/LSB. Find Vofs and Vo if the inputs are 10000000 and 10000110.	5	CO8	L3
19	1KT17EE006	Explain R/2R ladder technique of D/A converter.	5	CO8	L2
20	1KT17EE007	Explain the advantages of R/2R ladder technique over binary weighted resistor technique.	3	CO8	L4
21	1KT17EE008	Explain the successive approximation analog to digital converter technique with the help of a block diagram and an example.	5	CO8	L2
22	1KT17EE010	An 8-bit DAC has an output voltage range of 0-2.55V. Define the resolution in at least 2 ways.	3	CO8	L3
23	1KT17EE011	Explain the block diagram of IC 1408	5	CO8	L2
24	1KT17EE014	Explain the working of single slope ADC with the help of neat diagram.	5	CO8	L2
25	1KT17EE015	Explain the working of dual slope ADC with the help of neat diagram.	5	CO8	L2

D3. TEACHING PLAN - 3

Module – 5

Title:	Phase Locked Loop and 555 Timer	Appr Time:	10 Hrs
a	***Course Outcomes***	-	**Blooms**
-	The student should be able to:	-	**Level**
1	Demonstrate the application of Linear ICs as PLL using IC LM741C	CO9	L4
2	Design the application of Linear ICs as Multivibrator using IC 555.	CO10	L4
b	***Course Schedule***		
Class No	**Module Content Covered**	**CO**	**Level**
52	Basic of PLL	CO9	L2
53	PLL components:VCO	CO9	L2
54	PLL components:phase detector: switched type and balanced modulator type	CO9	L2
55	PLL components:phase detector:digital phase detector	CO9	L2
56	performance factors	CO9	L3
57	Timer: Internal architecture of 555 timer	CO10	L2
58	Mono stable multi vibrators	CO10	L2
59	Problems on Mono stable multi vibrators	CO10	L3
60	Applications of Mono stable multi vibrators	CO10	L2
61	Astable multi vibrator and applications	CO10	L3
c	**Application Areas**	**CO**	**Level**
1	PLL is used in motor speed control and tracking filter.	CO9	L4
2	Multi vibrators are used in delay , timing circuits , frequency dividers and to generate clock pulses for computer.	CO10	L4
d	**Review Questions**	-	-
1	What is phase locked loop.	CO9	L1
2	List the basic building blocks of PLL.	CO9	L1
3	What is the major difference between digital and analog PLLs.	CO9	L1
4	Briefly explain the roles of a low pass filter in PLLs.	CO9	L1
5	Briefly explain the roles of a VCO in PLLs.	CO9	L2
6	What are the advantages and disadvantages of monolithic PLL over descrete PLLs?	CO9	L4
7	List important features of 555 timer.	CO10	L1

8	What are the basic modes in which 555 timer operates?	CO10	L1
	Briefly explain the difference between the two operating modes of 555 timer.	CO10	L2
e	**Experiences**	-	-
1		CO9	L4
2			
3			
4		CO10	L4

E3. CIA EXAM – 3

a. Model Question Paper - 3

Crs Code:	18EE46	Sem:	4	Marks:	30	Time:	75 minutes
Course:	OP Amp and Linear Integrated						

-	-	Note: Answer any 2 questions, each carry equal marks.	Marks	CO	Level
1	a	What is PLL? Explain the working of the building blocks of PLL.	9	CO9	L2
	b	Write a note on application of PLL IC 565	6	CO9	L2
		OR			
2	a	Explain PLL based frequency multiplier and frequency synthesizer	10	CO9	L2
	b	Explain operating principle of PLL. Hence define lock range, capture range and pull in time	5	CO9	L2
3	a	Explain the functions of various pins of IC 555 timer.	10	CO10	L2
	b	An astable multivibrator is to be designed for getting rectangular waveform for tON = 0.6ms.Total time period = 1ms.Assume C = 0.1μF.Draw the circuit diagram.	5	CO10	L3
		OR			
4	a	Explain monostable multi vibrator circuit operation using op amp with waveforms.	7	CO10	L2
	b	Design a 555 based square wave generator to produce a symmetrical square wave of 1KHZ. If Vcc = 12V, draw the voltage across timing capacitor and the output.	8	CO10	L3

b. Assignment – 3

Note: A distinct assignment to be assigned to each student.

Model Assignment Questions							
Crs Code:	18EE46	Sem:	I	Marks:	5 / 10	Time:	90 – 120 minutes
Course:	OP Amp and Linear Integrated						
Note: Each student to answer 2-3 assignments. Each assignment carries equal mark.							

SNo	USN	Assignment Description	Marks	CO	Level
1	1KT16EE002	Explain the block diagram of PLL.	8	CO9	L2
	1KT16EE010	What is PLL? Explain the working of the building blocks of PLL.	8	CO9	L2
2	1KT16EE024	Explain PLL based frequency multiplier and frequency synthesizer.	8	CO9	L3
	1KT17EE002	Explain the various applications of PLL	10	CO9	L3
3	1KT17EE003	Write a note on application of PLL IC 565	5	CO9	L3
4	1KT17EE004	Explain operating principle of PLL. Hence define lock range, capture range and pull in time.	5	CO9	L2
5	1KT17EE006	Explain the functions of various pins of IC 555 timer.	10	CO10	L2
	1KT17EE007	Draw and explain the functional block diagram of IC 555.	10	CO10	L2
6	1KT17EE008	Explain monostable multivibrator circuit operation using op amp with waveforms.	6	CO10	L2
7	1KT17EE010	Explain astable multivibrator circuit operation using op amp with waveforms.	6	CO10	L2
8	1KT17EE011	Design a 555 astable multivibrator to give a 2KHZ pulse repetition frequency with a 70% duty cycle. Use Vcc = 18V.	6	CO10	L4
9	1KT17EE014	An astable multivibrator is to be designed for getting	6	CO10	L3

		rectangular waveform for tON = 0.6ms.Total time period = 1ms.Assume C = 0.1µF.Draw the circuit diagram.			
10	1KT17EE015	Design a 555 based square wave generator to produce a symmetrical square wave of 1KHZ. If Vcc = 12V, draw the voltage across timing capacitor and the output.	6	CO10	L4

F. EXAM PREPARATION

1. University Model Question Paper

Course:	OP Amp and Linear Integrated					Month / Year	May /2018
Crs Code:	18EE46	Sem:	4	Marks:	100	Time:	180 minutes

-	Note	Answer all FIVE full questions. All questions carry equal marks.	Marks	CO	Level
1	a	With a neat block diagram , explain the general stages of an OP-AM IC.	6	CO1	L2
	b	Explain the effect of feedback on input resistance, output resistance of a practical non inverting amplifier.	8	CO1	L3
	c	The 741C OP-AMP having the following parameters is connected as a inverting amplifier with R_1 =470Ω and R_F =4.7KΩ . A= 200,000, R_i = 2MΩ, R_o = 75Ω, f_o = 5HZ .Supply voltages = ±15V and output voltage swing = ±13V. Calculate A_F, R_{iF}, R_{oF} and f_F.	6	CO1	L3
		OR			
	a	Derive an expression for output voltage of differential summing amplifier.	5	CO2	L3
-	b	Derive the closed loop voltage gain of voltage series feedback amplifier	6	CO1	L3
	c	What is an instrumentation amplifier? For instrumentation amplifier using transducer bridge obtain an expression for output voltage Vo in terms of change in resistance **Δ**R of the transducer. Draw the circuit diagram.	9	CO2	L2
2	a	Derive the expression for gain and phase angle of first order low pass butter-worth filter.	7	CO3	L3
	b	Explain the following performance parameters of voltage regulator.I) Line Regulation. ii) Load Regulation iii) Ripple Rejection.	6	CO4	L2
	c	Design a high pass filter with a cut-off frequency of 10KHZ with a passband gain of 1.5	7	C03	L4
		OR			
	a	With a neat circuit diagram, explain the operation of a adjustable regulator using OP – AMP.	7	CO4	L2
	b	Explain in detail the all pass filter and mention applications.	6	CO3	L2
	c	An LM317 regulator is to provide 6v output from 15V supply. The load current is 200mA. Design the circuit, calculate the power dissipation. Draw the circuit diagram. Select I1 = 1mA, Vref – 1.25V	7	CO4	L3
3	a	Sketch the circuit of triangular/rectangular waveform generator. Draw the output waveforms from the circuit and explain its operation.	12	CO5	L2
	b	Design a RC phase shift oscillator for an output waveform frequency of 5KHZ.Use LM741 with **±15v power supply.**	8	CO5	L4
		OR			
	a	Explain the working of Wien bridge oscillator with the help of circuit diagram, waveforms and equations.	7	CO5	L2
	b	With a neat circuit diagram and waveforms. Explain the operation of inverting schmittrigger with different LTP and UTP. Draw its hysteresis curve.	7	CO6	L2
	c	Design a non inverting schmitt trigger circuit to have UTP = +3V and LTP = -5V.Use a 741 op-amp with VCC = ±15V.	6	CO6	L4
4	a	With a neat circuit diagram, show how a half wave precision rectifier can be combined with a summing circuit to produce a full wave precision rectifier. Draw the voltage waveforms at relevant stages of the circuit and write the equations to show that full wave rectification is proffered.	10	CO7	L2
	b	Define the following terms for D/A converters : resolution, settling time, conversion time, accuracy.	4	CO8	L4

-	c	Discuss the advantages of a precision rectifier over an ordinary diode circuit and show how the voltage gain can be achieved with a saturating precision rectifier.	6	CO7	L2
		OR			
	a	Explain R/2R ladder technique of D/A converter.	8	CO8	L2
	b	An 8-bit DAC has resolution of 20mv/LSB. Find Vofs and Vo if the inputs are 10000000 and 10000110.	4	CO8	L3
	c	Explain the successive approximation analog to digital converter technique with the help of a block diagram and an example.	8	CO8	L2
5	a	What is PLL? Explain the working of the building blocks of PLL.	8	CO9	L2
	b	Write a note on application of PLL IC 565	8	CO9	L2
	c	Explain operating principle of PLL. Hence define lock range, capture range and pull in time	4	CO9	L2
		OR			
	a	Explain the functions of various pins of IC 555 timer.	10	CO10	L2
-	b	Explain monostable multivibrator circuit operation using op amp with waveforms.	5	CO10	L2
	c	Design a 555 based square wave generator to produce a symmetrical square wave of 1KHZ. If Vcc = 12V, draw the voltage across timing capacitor and the output.	5	CO10	L4

2. SEE Important Questions

Course:	OP Amp and Linear Integrated Circuits				Month / Year	May /2018
Crs Code:	18EE46	Sem: 4	Marks: 100		Time:	180 minutes
	Note	Answer all FIVE full questions. All questions carry equal marks.		-	-	
Module	Qno.			**Marks**	**CO**	**Year**
1	1	With a neat block diagram , explain the general stages of an OP-AM IC.		6	CO1	2004
	2	Explain the effect of feedback on input resistance, output resistance of a practical non inverting amplifier.		8	CO1	2004
	3	The 741C OP-AMP having the following parameters is connected as a inverting amplifier with R_1 =470Ω and R_F =4.7KΩ . A= 200,000, R_i = 2MΩ, R_o = 75Ω, f_o = 5HZ .Supply voltages = ±15V and output voltage swing = ±13V. Calculate A_F, R_{iF}, R_{oF} and f_F.		6	CO1	2004
	4	Derive an expression for output voltage of differential summing amplifier		5	CO2	2007
	5	Derive the closed loop voltage gain of voltage series feedback amplifier		6	CO1	2010
	6	What is an instrumentation amplifier? For instrumentation amplifier using transducer bridge obtain an expression for output voltage Vo in terms of change in resistance ΔR of the transducer. Draw the circuit diagram.		9	CO2	2005
2	1	Derive the expression for gain and phase angle of first order low pass butter-worth filter.		7	CO3	2009
	2	Explain the following performance parameters of voltage regulator.I) Line Regulation. ii) Load Regulation iii) Ripple Rejection.		6	CO4	2006
	3	Design a high pass filter with a cut-off frequency of 10KHZ with a passband gain of 1.5		7	Co3	2004
	4	With a neat circuit diagram, explain the operation of a adjustable regulator using OP – AMP.		7	CO4	2006
	5	Explain in detail the all pass filter and mention applications.		6	CO3	2006
	6	An LM317 regulator is to provide 6v output from 15V supply. The load current is 200mA. Design the circuit, calculate the power dissipation. Draw the circuit diagram. Select I1 = 1mA, Vref – 1.25V		7	CO4	2007
3	1	Sketch the circuit of triangular/rectangular waveform generator. Draw the output waveforms from the circuit and explain its operation.		12	CO5	2004
	2	Design a RC phase shift oscillator for an output waveform frequency of		8	CO5	2004

		5KHZ.Use LM741 with ±15v power supply.			
	3	Explain the working of Wien bridge oscillator with the help of circuit diagram, waveforms and equations.	7	CO5	2004
	4	With a neat circuit diagram and waveforms. Explain the operation of inverting schmittrigger with different LTP and UTP. Draw its hysteresis curve.	7	CO6	2004
	5	Design a non inverting schmitt trigger circuit to have UTP = +3V and LTP = -5V.Use a 741 op-amp with VCC = ±15V.	6	CO6	2006
4	1	With a neat circuit diagram, show how a half wave precision rectifier can be combined with a summing circuit to produce a full wave precision rectifier. Draw the voltage waveforms at relevant stages of the circuit and write the equations to show that full wave rectification is proffered.	10	CO7	2007
	2	Define the following terms for D/A converters : resolution, settling time, conversion time, accuracy.	4	CO8	2010
	3	Discuss the advantages of a precision rectifier over an ordinary diode circuit and show how the voltage gain can be achieved with a saturating precision rectifier.	6	CO7	2009
	4	Explain R/2R ladder technique of D/A converter.	8	CO8	2007
	5	An 8-bit DAC has resolution of 20mv/LSB. Find Vofs and Vo if the inputs are 10000000 and 10000110.	4	CO8	2004
	6	Explain the successive approximation analog to digital converter technique with the help of a block diagram and an example.	8	CO8	2005
5	1	What is PLL? Explain the working of the building blocks of PLL.	8	CO9	2011
	2	Write a note on application of PLL IC 565	8	CO9	2012
	3	Explain operating principle of PLL. Hence define lock range, capture range and pull in time	4	CO9	2014
	4	Explain the functions of various pins of IC 555 timer.	10	CO10	2015
	5	Explain monostable multivibrator circuit operation using op amp with waveforms.	5	CO10	2016
	6	Design a 555 based square wave generator to produce a symmetrical square wave of 1KHZ. If Vcc = 12V, draw the voltage across timing capacitor and the output.	5	CO10	2017

G. Content to Course Outcomes

1. TLPA Parameters

Table 1: TLPA – Example Course

Module-#	Course Content or Syllabus (Split module content into 2 parts which have similar concepts)	Content Teaching Hours	Blooms' Learning Levels for Content	Final Blooms' Level	Identified Action Verbs for Learning	Instruction Methods for Learning	Assessment Methods to Measure Learning
A	*B*	*C*	*D*	*E*	*F*	*G*	*H*
1	**Operational amplifiers**: Introduction, Block diagram representation of a typical Op-amp, schematic symbol, characteristics of an Op-amp, ideal op-amp, equivalent circuit, ideal voltage transfer curve,open loop configuration, differential amplifier, inverting & non –inverting amplifier, Op-amp with negative feedback(excluding derivations).	5	L1,L2	L2	Understand	Lecture	Unit Test and assignment
1	**General Linear Applications:** A.C. amplifier, summing, scaling & averaging amplifier, inverting and non-inverting configuration, Instrumentation amplifier	5	L2,L3	L4	Analyse	Lecture	Unit Test and assignment
2	**Active Filters:** First & Second order high pass	8	L2,L3,L4	L4	Analyze	Lecture	Unit Test

	& low pass Butterworth filters. Band pass filters,all pass filters.						and assignment
2	**DC Voltage Regulators:** voltage regulator basics, voltage follower regulator, adjustable output regulator, LM317 & LM337 Integrated circuits regulators.	8	L2,L3,L4	L4	Analyse	Lecture	Unit Test and assignment
3	**Signal generators:** Triangular / rectangular wave generator, phase shift oscillator, saw tooth oscillator.	7	L2,L3,L4	L4	Analyse	Lecture	Unit Test and assignment
3	**Comparators & Converters:** Basic comparator, zero crossing detector, inverting & non-inverting Schmitt trigger circuit, voltage to current converter with grounded load, current to voltage converter and basics of voltage to frequency and frequency to voltage converters	8	L2,L3,L4	L4	Analyse	Lecture	Unit Test and assignment
4	**Signal processing circuits:** Precision half wave & full wave rectifiers	5	L2,L3,L4	L4	Analyse	Lecture	Unit Test and assignment
4	**A/D & D/A Converters:** Basics, R–2R D/A Converter, Integrated circuit 8-bit D/A, successive approximation ADC, linear ramp ADC.	5	L2,L3,L4	L4	Analyse	Lecture/ PPT	Unit Test and assignment
5	P**hase Locked Loop (PLL):** Basic PLL, components, performance factors.	5	L2,L3	L3	understand	Lecture/ PPT	Unit Test and assignment
5	**Timer:** Internal architecture of 555 timer, Mono stable multi vibrators and applications.	5	L2,L3,L4	L4	Analyse	Lecture/ PPT	Unit Test and assignment

2. Concepts and Outcomes:

Table 2: Concept to Outcome – Example Course

Module-#	Learning or Outcome from study of the Content or Syllabus	Identified Concepts from Content	Final Concept	Concept Justification (What all Learning Happened from the study of Content / Syllabus. A short word for learning or outcome)	CO Components (1.Action Verb, 2.Knowledge, 3.Condition / Methodology, 4.Benchmark)	Course Outcome **Student Should be able to ...**
A	*I*	*J*	*K*	*L*	*M*	*N*
1	-Block diagram representation of a typical Op-amp -characteristics of an Op-amp, -ideal voltage transfer curve -open loop configuration, differential	- OP-AMP Charecteristics - OP-AMP configurations -Feedback	Charecteristics and configurations	OP Amp characteristics and its various configurations.	1.Describe 2.the characteristics of ideal and practical operational amplifier.	Describe the characteristics of ideal and practical operational amplifier.

	amplifier, inverting & non –inverting amplifier, -Op-amp with negative feedback					
1	-A.C. amplifier -summing, scaling & averaging amplifier - Instrumentation amplifier	-Linear operations - mathematical operations -OP AMP application in instrumentation	Linear and mathematical operations.	Many operations using Op Amp	1.Design 2.the linear applications of OP-AMP 3.using IC LM741C .	Design the linear applications of OP-AMP using IC LM741C .
2	**-**First & Second order high pass & low pass Butterworth filters. -Band pass filters -all pass filters.	-Low frequency signal filtering - High signal filtering - Band of frequency signal filtering -All frequency signal filtering	Signal Filtering.	Op Amp as various types of filters	Design filters using linear IC LM741C.	Design filters using linear IC LM741C.
2	**-**voltage regulator basics -voltage follower regulator -adjustable output regulator, -LM317 & LM337 Integrated circuits regulators.	- voltage regulator stages -Fixed voltage regulation -Adjustable voltage regulation	Voltage Regulation	Design of regulator using Op Amp	1.Design 2.DC Regulated power supply 3. using regulators IC's LM317 and LM337.	Design DC Regulated power supply using regulators IC's LM317 and LM337.
3	-Triangular / rectangular wave generator -phase shift oscillator - saw tooth oscillator.	-Triangular / rectangular wave generation -Sin wave generatio	Signal Generation.	Generation of square, triangular,sine and sawtooth wave generator using Op Amp.	1.Design 2.signal generators 3.using linear IC LM741C.	Design signal generators using linear IC LM741C.

		n - Sawtooth wave generatio n				
3	-Basic comparator, zero crossing detector, -inverting & non-inverting Schmitt trigger circuit, -voltage to current converter with grounded load, current to voltage converter -basics of voltage to frequency and frequency to voltage converters	-Voltage comparisi on -voltage to current conversio n and vice versa -voltage to frequency conversio n and vice versa	Comparison and conversion	Design of ZCD , Schmitt trigger and converters using Op Amp.	1.Design 2.the application of Linear ICs as comparators and Converter 3.using IC LM741C.	Design the application of Linear ICs as comparators and Converter using IC LM741C.
4	**-** Precision half wave and full wave rectifiers	-Half wave rectificatio n -Full wave rectificatio n	Rectification	Design of Half and Full pricision rectifier using Op Amp	1.Design 2.the application of Linear ICs as rectifiers 3.using IC LM741C.	Design the application of Linear ICs as rectifiers using IC LM741C.
4	-Basics -R–2R D/A Converter, Integrated circuit 8-bit D/A -successive approximatio n ADC, linear ramp ADC.	- Terminolo gies of code conversio n -Analog to digital code conversio n. - Digital to analog code conversio n	A/D and D/A Convertion	Working of Succesive approximation ADC and linear ramp DAC.	1.Demonstrate 2.the application of Linear ICs as A/D and D/A converter 3.using IC LM741C.	Demonstrate the application of Linear ICs as A/D and D/A converter using IC LM741C.
5	**-**Basic PLL -components -performance factors.	-Phase lock mechanis m -PLL Structure - Performa	Phase and frequency locking	Basics of PLL and its applications using Op Amp	1.Demonstrate 2.the application of Linear ICs as PLL 3.using IC LM741C	Demonstrate the application of Linear ICs as PLL using IC LM741C

		nce factors				
5	**-**Internal architecture of 555 timer -Mono stable multi vibrators -applications.	-Architecture of 555 timer -Different width pulse generation.	Pulse Generation	Design of astable and monostable multivibrator using 555 timer.	1.Design 2.the application of Linear ICs as Multivibrator 3.using IC 555.	Design the application of Linear ICs as Multivibrator using IC 555.