ANALOG ELECTRONICS **Course Code : 313324**

Programme Name/s	**: Digital Electronics/ Electronics & Tele-communication Engg./ Electronics & Communication Engg./ Electronics Engineering/ Instrumentation & Control/ Industrial Electronics/ Instrumentation/ Medical Electronics/ Electronics & Computer Engg.**
Programme Code	**: DE/ EJ/ ET/ EX/ IC/ IE/ IS/ MU/ TE**
Semester	**: Third**
Course Title	**: ANALOG ELECTRONICS**
Course Code	**: 313324**

I. RATIONALE

Analog electronic circuits are the basic building blocks of many complex electronic system. Therefore it is necessary for students to understand the working principle and testing of basic analog circuits consist of discrete components and integrated circuits. After learning this course students will be able to apply the concept of working of basic electronic circuit and Op-Amp circuits to maintain the electronic system.

II. INDUSTRY / EMPLOYER EXPECTED OUTCOME

The aim of this course is to attain the following industry/ employer expected outcome through various teaching learning experiences:
Maintain analog electronic circuits.

III. COURSE LEVEL LEARNING OUTCOMES (COS)

Students will be able to achieve & demonstrate the following COs on completion of course based learning

- CO1 - Use transistor as a Power Amplifier.
- CO2 - Construct various configurations of Op-Amp for different applications.
- CO3 - Maintain different waveform generator circuits.
- CO4 - Analyze active filters used in various electronic circuits.
- CO5 - Use specific analog IC to develop various applications.

IV. TEACHING-LEARNING & ASSESSMENT SCHEME

Course Code	Course Title	Abbr	Course Category/s	Learning Scheme					Credits	Assessment Scheme												
				Actual Contact Hrs./Week			SLH	NLH		Paper Duration	Theory				Based on LL & TL				Based on SL		Total Marks
															Practical							
				CL	TL	LL					FA-TH	SA-TH	Total		FA-PR		SA-PR		SLA		
											Max	Max	Max	Min	Max	Min	Max	Min	Max	Min	
313324	ANALOG ELECTRONICS	ATE	DSC	3	-	4	1	8	4	3	30	70	100	40	25	10	25#	10	25	10	175

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Total IKS Hrs for Sem. : 0 Hrs
Abbreviations: CL- ClassRoom Learning , TL- Tutorial Learning, LL-Laboratory Learning, SLH-Self Learning Hours, NLH-Notional Learning Hours, FA - Formative Assessment, SA -Summative assessment, IKS - Indian Knowledge System, SLA - Self Learning Assessment
Legends: @ Internal Assessment, # External Assessment, *# On Line Examination , @$ Internal Online Examination
Note :

1. FA-TH represents average of two class tests of 30 marks each conducted during the semester.
2. If candidate is not securing minimum passing marks in FA-PR of any course then the candidate shall be declared as "Detained" in that semester.
3. If candidate is not securing minimum passing marks in SLA of any course then the candidate shall be declared as fail and will have to repeat and resubmit SLA work.
4. Notional Learning hours for the semester are (CL+LL+TL+SL)hrs.* 15 Weeks
5. 1 credit is equivalent to 30 Notional hrs.
6. * Self learning hours shall not be reflected in the Time Table.
7. * Self learning includes micro project / assignment / other activities.

V. THEORY LEARNING OUTCOMES AND ALIGNED COURSE CONTENT

Sr.No	Theory Learning Outcomes (TLO's)aligned to CO's.	Learning content mapped with Theory Learning Outcomes (TLO's) and CO's.	Suggested Learning Pedagogies.
1	TLO 1.1 Describe the performance of the given power amplifier parameters. TLO 1.2 Explain with sketches the working of given type of power amplifier. TLO 1.3 Compare the given type of power amplifiers on the basis of performance parameter. TLO 1.4 Select relevant type of power amplifier for the given applications.	**Unit - I Power Amplifiers** 1.1 Power Amplifier: Concept, Performance parameters like: Gain, Bandwidth, frequency band, efficiency and distortion 1.2 Classification: Class A, Class B, Class AB and Class C power amplifier and their applications 1.3 Circuit diagram, working, input output waveforms and efficiency of single stage Class A, Class B, Class AB and Class C power amplifier, Push Pull amplifier, Complementary symmetry push–pull amplifier. Transformer less push-pull amplifier. Distortions in Power amplifier 1.4 Generalised features of audio power amplifier IC's, Heat Sink	Lecture Using Chalk-Board Video Demonstrations Assignments

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Sr.No	Theory Learning Outcomes (TLO's)aligned to CO's.	Learning content mapped with Theory Learning Outcomes (TLO's) and CO's.	Suggested Learning Pedagogies.
2	TLO 2.1 Describe with sketches the function of the given block(s) of Op-Amp. TLO 2.2 List ideal characteristics of Op-Amp. TLO 2.3 Define the given parameters of Op-Amp. TLO 2.4 Interpret the output waveform of given mode of operation of Op-Amp. TLO 2.5 Calculate the output voltage of given arithmetic circuit consist of Op-Amp. TLO 2.6 Describe the working of the given application circuit consist of Op-Amp.	**Unit - II Op-Amp and its applications** 2.1 Op-Amp: block diagram, symbol, characteristics, open loop and closed loop amplifier, virtual ground concept, IC-741 and it's pin configuration 2.2 Op-Amp parameters: input offset voltage, output offset voltage, input offset current, input bias current, Common Mode Rejection Ratio, Power supply rejection ratio ,slew rate, input and output Impedance, bandwidth and gain bandwidth product, Drift parameters 2.3 Closed loop configurations: inverting and non-inverting 2.4 Basic mathematical applications such as adder, subtractor, integrator and differentiator 2.5 Sample and Hold circuit, I-V converter, V-I converter 2.6 Comparator: Zero Crossing Detector (Inverting and Non Inverting type), Schmitt Trigger, Window Detector and Peak Detector	Lecture Using Chalk-Board Video Demonstrations Assignments
3	TLO 3.1 Explain the principle of positive and negative feedback for amplifier circuit. TLO 3.2 State Barkhausen's criteria for oscillation. TLO 3.3 Describe the working principle of given type of oscillator. TLO 3.4 Calculate the frequency of oscillation for given oscillator. TLO 3.5 Select the circuit components of the given type of oscillator for given operating frequency.	**Unit - III Waveform Generators** 3.1 Principle of feedback amplifier. Types of feedback: Negative and Positive feedback, advantages and disadvantages of negative feedback, Types of feedback connections (Block Diagrams and features only) 3.2 Oscillator: need of oscillator, compare oscillator and amplifier 3.3 Condition for oscillations: Barkhausen's criteria, classification of oscillator 3.4 Oscillators Circuits : Phase shift oscillator using IC 741 , Hartley oscillator using IC 741 and crystal oscillator using BJT & FET	Lecture Using Chalk-Board Video Demonstrations Assignments Blended Classroom
4	TLO 4.1 Describe with circuit diagram working of the given type of filter. TLO 4.2 Identify the type of filter based on given frequency response. TLO 4.3 Calculate the cut off frequency of given type of filter. TLO 4.4 Develop given type and order of active filter for the given cut off frequency.	**Unit - IV Active Filters** 4.1 Definition, type of filters and difference between active and passive filter 4.2 Merits and demerits of active filter over passive filter 4.3 Terms related to filters: Order of filter, cut off frequency, Pass band, Stop band, Center frequency, Roll off rate, Bandwidth and Q factor 4.4 Order and frequency response: First and second order of low pass and high pass filter	Lecture Using Chalk-Board Assignments Video Demonstrations Blended Learning Tools

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Sr.No	Theory Learning Outcomes (TLO's)aligned to CO's.	Learning content mapped with Theory Learning Outcomes (TLO's) and CO's.	Suggested Learning Pedagogies.
5	TLO 5.1 Develop a circuit for the given application using IC-555. TLO 5.2 Calculate the duty cycle of the given type of multivibrator. TLO 5.3 Describe the working of given block of PLL. TLO 5.4 Develop a circuit for the given application using IC-565.	**Unit - V Specialized IC Applications** 5.1 Timer IC: IC 555 block diagram, pin diagram and functions, Astable and Monostable multivibrators, Voltage Controlled Oscillator 5.2 Phase Lock Loop (PLL) : IC 565 pin diagram, block diagram and it's working, Lock range and Capture range 5.3 Applications of PLL: PLL as a frequency multiplier, FM Demodulator	Lecture Using Chalk-Board Assignments Video Demonstrations Blended Learning Tools

VI. LABORATORY LEARNING OUTCOME AND ALIGNED PRACTICAL / TUTORIAL EXPERIENCES.

Practical / Tutorial / Laboratory Learning Outcome (LLO)	Sr No	Laboratory Experiment / Practical Titles / Tutorial Titles	Number of hrs.	Relevant COs
LLO 1.1 Interpret the operation of single stage Class A power amplifier.	1	* Test the performance of single stage Class A power amplifier.	2	CO1
LLO 2.1 Interpret the operation of Class B push pull power amplifier.	2	* Test the performance of Class B push pull power amplifier.	2	CO1
LLO 3.1 Interpret the operation of Class AB power amplifier.	3	Test the performance of Class AB power amplifier.	2	CO1
LLO 4.1 Measure output voltage swing of Op-Amp (IC 741).	4	* Determine the range of output voltage swing of Op-Amp (IC 741).	2	CO2
LLO 5.1 Measure input offset voltage and output offset voltage of IC 741.	5	* Build the circuit to measure input offset voltage and output offset voltage of IC 741.	2	CO2
LLO 6.1 Connect IC 741 in inverting and non-inverting mode. LLO 6.2 Measure the voltage gain of inverting and non-inverting amplifier circuit using IC 741.	6	* Determine the gain of inverting and non-inverting amplifier using IC 741.	2	CO2
LLO 7.1 Select the proper range of multimeter to measure the voltage. LLO 7.2 Measure output voltage of adder circuit consist of IC 741.	7	* Build /Test adder circuit consist of IC 741.	2	CO2
LLO 8.1 Select the proper range of multimeter to measure the voltage. LLO 8.2 Measure output voltage of subtractor circuit consist of IC 741.	8	Build /Test subtractor circuit consist of IC 741.	2	CO2
LLO 9.1 Use function generator. LLO 9.2 Interpret input and output waveforms of Integrator circuit consist of IC 741.	9	* Build /Test Integrator circuit consist of IC 741.	2	CO2
LLO 10.1 Use function generator. LLO 10.2 Interpret input and output waveforms of Differentiator circuit consist of IC 741.	10	* Build /Test Differentiator circuit consist of IC 741.	2	CO2

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Practical / Tutorial / Laboratory Learning Outcome (LLO)	Sr No	Laboratory Experiment / Practical Titles / Tutorial Titles	Number of hrs.	Relevant COs
LLO 11.1 Measure output current of V to I converter circuit using IC 741.	11	* Build/ Test V to I converter circuit using IC 741.	2	CO2
LLO 12.1 Interpret output voltage waveform of zero crossing detector.	12	* Build the circuit of zero crossing detector and test the output.	2	CO2
LLO 13.1 Check the performance of feedback on the output voltage of amplifier.	13	Use transistor to build/test voltage series feedback amplifier with feedback.	2	CO3
LLO 14.1 Check the performance of feedback on the output voltage of amplifier.	14	Use transistor to build/test voltage shunt feedback amplifier with feedback.	2	CO3
LLO 15.1 Check the performance of amplifier for positive and negative feedback.	15	* Test the effect of positive and negative feedback on the output voltage of given amplifier.	2	CO3
LLO 16.1 Measure the output frequency of RC phase shift oscillator based on IC 741.	16	* Test the circuit to measure the frequency of oscillation of the given RC phase shift oscillator consist of IC 741.	2	CO3
LLO 17.1 Measure the output frequency of Crystal Oscillator	17	Test the circuit of transistorised Crystal Oscillator	2	CO3
LLO 18.1 Measure the output frequency of Hartley Oscillator consist of IC 741.	18	Test the Hartley Oscillator based on IC 741.	2	CO3
LLO 19.1 Observe the output waveform of Hartley Oscillator.	19	Simulate the working of Hartley Oscillator using multisim or relevant software.	2	CO3
LLO 20.1 Measure bandwidth and cut off frequency of low pass filter. LLO 20.2 Plot the frequency response of low pass filter.	20	* Build and test the circuit of first order low pass filter.	2	CO4
LLO 21.1 Measure bandwidth and cut off frequency of high pass filter. LLO 21.2 Plot the frequency response of high pass filter.	21	* Build and test the circuit of first order high pass filter.	2	CO4
LLO 22.1 Observe the output waveform of high pass filter.	22	Simulate the working of high pass filter consist of IC 741 using multisim or relevant software.	2	CO4
LLO 23.1 Select the proper value of R and C for generating waveform of specific duty cycle.	23	* Build / test astable multivibrator using IC 555 for the specific duty cycle.	2	CO5
LLO 24.1 Measure the time period of monostable multivibrator using IC 555.	24	Build / test monostable multivibrator using IC 555 for the specific duty cycle.	2	CO5
LLO 25.1 Observe the output waveform of monostable multivibrator.	25	Simulate the working of monostable multivibrator using IC 555 using multisim or relevant software.	2	CO5
LLO 26.1 Check the performance of Voltage Controlled Oscillator using IC 555.	26	* Build/ Test Voltage Controlled Oscillator using IC 555.	2	CO5

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Practical / Tutorial / Laboratory Learning Outcome (LLO)	Sr No	Laboratory Experiment / Practical Titles / Tutorial Titles	Number of hrs.	Relevant COs
LLO 27.1 Measure the output frequency of multiplier circuit consist of IC565.	27	Build/ test the circuit of frequency multiplier using PLL IC 565.	2	CO5
LLO 28.1 Interpret input and output waveform of FM demodulator circuit contains PLL (IC 565).	28	Check the performance of PLL as FM demodulator (IC 565).	2	CO5

Note : Out of above suggestive LLOs -

- '*' Marked Practicals (LLOs) Are mandatory.
- Minimum 80% of above list of lab experiment are to be performed.
- Judicial mix of LLOs are to be performed to achieve desired outcomes.

VII. SUGGESTED MICRO PROJECT / ASSIGNMENT/ ACTIVITIES FOR SPECIFIC LEARNING / SKILLS DEVELOPMENT (SELF LEARNING)

Micro project

- 1) Construct audio amplifier using IC LM386N or equivalent IC.
- 2) Develop clap switch using IC 741.
- 3) Build automatic light operated switch using LDR and IC 741.
- 4) Build automatic evening lamp using IC 555 or equivalent IC.
- 5) Construct square wave generator using IC 741 or equivalent.
- 6) Develop low pass filter/high pass filter with cut off frequency of 2KHz using universal IC UAF42 or equivalent IC.

Note :

- Above is just a suggestive list of microprojects and assignments; faculty must prepare their own bank of microprojects, assignments, and activities in a similar way.
- The faculty must allocate judicial mix of tasks, considering the weaknesses and / strengths of the student in acquiring the desired skills.
- If a microproject is assigned, it is expected to be completed as a group activity.
- SLA marks shall be awarded as per the continuous assessment record.
- If the course does not have associated SLA component, above suggestive listings is applicable to Tutorials and maybe considered for FA-PR evaluations.

VIII. LABORATORY EQUIPMENT / INSTRUMENTS / TOOLS / SOFTWARE REQUIRED

Sr.No	Equipment Name with Broad Specifications	Relevant LLO Number
1	Cathode Ray Oscilloscope Dual Trace 20Mhz/30Mhz, 1Mega ohm Input Impedance.	1,2,3,9,10,12,13,14,15,16,17,18,19,20,21,22,23,24,25,26
2	Digital Storage Oscilloscope 20MHz and above, 1Mega ohm Input Impedance.	1,2,3,9,10,12,13,14,15,16,17,18,19,20,21,22,23,24,25,26
3	Function Generator 0-2 MHz with sine, square and triangular output with variable amplitude and frequency.	1,2,3,9,10,12,13,14,15,19,20,21,22,23,24,25,26
4	Simulation software like: TINA-TI/Multisim etc. or any other open-source simulation software can be used.	19,22,25

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Sr.No	Equipment Name with Broad Specifications	Relevant LLO Number
5	Dual Tracking Power Supply 0-30V,2 A, short circuit and over voltage protection.	3,4,5,6,7,8,9,10,11,16,17,18,19,20,21
6	Analog IC tester with tests Op-amp,555, IC testing 741 , 555 ,556 ,565 it has Auto search facility of IC's Test by: Truth table/sequence table comparison ZIF: 40 pin DIP ZIF sockets.	4,5,6,7,8,9,10,11,12,16,17,18,19,20,21,22,23,24,25,26
7	Variable DC power supply 0-30V, 2A with short circuit and over voltage protection.	All
8	Digital Multimeter: Minimum 3 ½ digit 4 ½ digit display,9999 counts digital multimeter measures Vac, Vdc(1000V max) , Adc, Aac (10 amp max), Resistance(0-100 M ohm), diode and transistor testing mode.	All

IX. SUGGESTED WEIGHTAGE TO LEARNING EFFORTS & ASSESSMENT PURPOSE (Specification Table)

Sr.No	Unit	Unit Title	Aligned COs	Learning Hours	R-Level	U-Level	A-Level	Total Marks
1	I	Power Amplifiers	CO1	8	4	4	4	12
2	II	Op-Amp and its applications	CO2	11	4	6	8	18
3	III	Waveform Generators	CO3	8	4	4	6	14
4	IV	Active Filters	CO4	8	4	4	6	14
5	V	Specialized IC Applications	CO5	10	4	4	4	12
Grand Total				**45**	**20**	**22**	**28**	**70**

X. ASSESSMENT METHODOLOGIES/TOOLS

Formative assessment (Assessment for Learning)

- Two offline unit tests of 30 marks and average of two unit test marks will be consider for out of 30 marks.
- For formative assessment of laboratory learning 25 marks.
- Each practical will be assessed considering 60% weightage to process, 40% weightage to product.

Summative Assessment (Assessment of Learning)

- End semester assessment is of 70 marks.
- End semester summative assessment is of 25 marks for laboratory learning.

XI. SUGGESTED COS - POS MATRIX FORM

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Course Outcomes (COs)	Programme Outcomes (POs)							Programme Specific Outcomes* (PSOs)		
	PO-1 Basic and Discipline Specific Knowledge	PO-2 Problem Analysis	PO-3 Design/ Development of Solutions	PO-4 Engineering Tools	PO-5 Engineering Practices for Society, Sustainability and Environment	PO-6 Project Management	PO-7 Life Long Learning	PSO-1	PSO-2	PSO-3
CO1	3	1	2	2	1	--	2			
CO2	3	2	2	2	1	--	2			
CO3	2	2	2	2	1	1	2			
CO4	2	3	2	1	1	1	1			
CO5	2	3	2	2	1	1	2			

Legends :- High:03, Medium:02,Low:01, No Mapping: -
*PSOs are to be formulated at institute level

XII. SUGGESTED LEARNING MATERIALS / BOOKS

Sr.No	Author	Title	Publisher with ISBN Number
1	Sedha R.S.	Applied Electronics	S.Chand, New Delhi,2015 ISBN:9788121927833
2	Gayakwad Ramakant A.	Op-Amps and Linear Integrated Circuits	PHI Learning, New Delhi 2011, ISBN:9788120320581
3	Salivahanan S., Bhaaskaran Kanchana V. S.	Linear Integrated Circuits	Tata McGraw-Hill Education,New Delhi, 2018, ISBN: 9789353160487
4	Chaudhary D. Roy	Linear Integrated Circuits	New Age International Publishers ISBN: 9788122420906
5	S. Salivahanan, N. Suresh Kumar	Electronic Devices and Circuits	McGraw Hill Education, Edition-Fourth, ISBN-9789339219505

XIII . LEARNING WEBSITES & PORTALS

Sr.No	Link / Portal	Description
1	https://www.youtube.com/watch?v=mgoCeOCjiBI	Basic of Op-Amp.
2	https://youtu.be/dKTbrZMscpM?si=6lQ3xdhGvLDZL-VL	Class A Power Amplifier
3	https://www.youtube.com/watch?v=BfjdB09V1NQ&list=PLuv3GM6-gsE3npYPJJDnEF3pdiHZT6Kj3&index=22	Op-Amp as Integrator
4	https://www.youtube.com/watch?v=M3yI0byaqKc&list=PLuv3GM6-gsE3npYPJJDnEF3pdiHZT6Kj3&index=27	Introduction to Oscillator.
5	https://www.youtube.com/watch?v=aeQoEnH74C8&list=PLuv3GM6-gsE3npYPJJDnEF3pdiHZT6Kj3&index=31	Working of Crystal Oscillator.
6	https://www.elprocus.com/op-amp-applications-in-electronics/	Applications of Op-Amp.
7	https://testbook.com/electrical-engineering/power-amplifier-definition-types-and-uses	Power Amplifiers

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Sr.No	Link / Portal	Description
8	http://vlabs.iitkgp.ac.in/be/exp17/inverting_opamp.html	Virtual Lab for Inverting Amplifier
9	https://ae-iitr.vlabs.ac.in/exp/astable-monostable-multivibrator/simulation/astable/exp.html?	Virtual Lab for Multivibrators using Op-Amp.

Note :

- Teachers are requested to check the creative common license status/financial implications of the suggested online educational resources before use by the students

MSBTE Approval Dt. 02/07/2024 **Semester - 3, K Scheme**