Year / Semester: II B.Tech IV Semester   **Regulation: R23**

Subject and Code:Electronic Circuit Analysis (23ECE242T)

SYLLABUS

23ECE242	ELECTRONIC CIRCUITS ANALYSIS	L T P C
		2 1 - 3

COURSE EDUCATIONAL OBJECTIVES:

1. Understand the characteristics of multistage and Differential amplifiers.
2. Analyze the frequency response of BJT and FET amplifiers
3. Understand the characteristics of feedback amplifiers.
4. Categorize different oscillator circuits based on the application and analyze the tuned amplifiers.
5. Analyze the power amplifiers for various applications.

UNIT 1: MULTISTAGE AND DIFFERENTIAL AMPLIFIERS

Introduction –Classification of Amplifiers- Distortion in amplifiers, Coupling Schemes, RC Coupled Amplifier using BJT, Cascaded RC Coupled BJT Amplifiers, Cascode amplifier, Darlington pair, the MOS Differential Pair, Small-Signal Operation of the MOS Differential Pair, The BJT Differential Pair, and other Nonideal Characteristics of the Differential Amplifier.

UNIT –2: FREQUENCY RESPONSE

Low-Frequency Response of the CS and CE Amplifiers, Internal Capacitive Effects and the High-Frequency Model of the MOSFET and the BJT, High-Frequency Response of the CS, follower, CE, CG and Cascode Amplifiers.

UNIT –3: FEEDBACK AMPLIFIERS

Feedback Amplifiers: Introduction, The General Feedback Structure, Some Properties of Negative Feedback, The Four Basic Feedback Topologies, The Feedback Voltage Amplifier (Series—Shunt), The Feedback Transconductance Amplifier (Series—Series), The Feedback Trans-Resistance Amplifier (Shunt—Shunt), The Feedback Current Amplifier (Shunt—Series).

UNIT –4: OSCILLATORS AND TUNED AMPLIFIERS

Oscillators: General Considerations, Phase Shift Oscillator, Wien-Bridge Oscillator, LC Oscillators, Relaxation Oscillator, Crystal Oscillators, Illustrative Problems.
Tuned Amplifiers: Basic Principle, Use of Transformers, Single Tuned Amplifiers, Amplifiers with multiple Tuned Circuits, Stagger Tuned Amplifiers.

UNIT –5: POWER AMPLIFIERS

Introduction, Classification of Output Stages, Class A Output Stage, Class B Output Stage, Class AB Output Stage, Biasing the Class AB Circuit, CMOS Class AB Output Stages, Power BJTs, Variations on the Class AB Configuration, Class C amplifier, MOS Power Transistors.

Total Hours: 45

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COURSE OUTCOMES:

On successful completion of the course, students will be able to		POs
CO1	Understand the characteristics of multistage and differential amplifiers.	PO1, PO2, PO3, PO4
CO2	Examine the frequency response of multistage and high frequencies.	PO1, PO2, PO3, PO4
CO3	Investigate different feedback amplifiers based on the application.	PO1, PO2, PO3, PO4
CO4	Derive the expressions for frequency of oscillation and condition for oscillation of RC and LC oscillator circuits. Evaluate the performance of different tuned amplifiers	PO1, PO2, PO3, PO4
CO5	Understand the characteristics of power amplifiers.	PO1, PO2, PO3, PO4

TEXT BOOKS:

1. Millman, C Chalkias, "Integrated Electronics", 4thEdition, McGraw Hill Education (India) Private Ltd., 2015.
2. Adel. S. Sedra and Kenneth C. Smith, "Micro Electronic Circuits," 6th Edition, Oxford University Press, 2011.

REFERENCE BOOKS:

1. Behzad Razavi, "Fundamentals of Micro Electronics", Wiley, 2010.
2. Donald A Neamen, "Electronic Circuits – Analysis and Design," 3rdEdition, McGraw Hill (India), 2019.
3. Robert L. Boylestad and Louis Nashelsky, "Electronic Devices and Circuits Theory", 9th Edition, Pearson/Prentice Hall, 2006.

REFERENCE WEBSITE:

1. https://nptel.ac.in/courses/112/103/112103109/
2. https://nptel.ac.in/courses/122/104/122104015/
3. https://www.digimat.in/nptel/courses/video/112106180/L01.html
4. https://nptel.ac.in/courses/112/106/112106286/
5. https://nptel.ac.in/courses/112/105/112105164/
6. https://nptel.ac.in/courses/112/103/112103108/
7. https://nptel.ac.in/courses/122/104/122104014/

CO-PO MAPPING:

CO\PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO.1	3	2	2	2	-	-	-	-	-	-	-	-
CO.2	3	2	2	2	-	-	-	-	-	-	-	-
CO.3	3	2	2	2	-	-	-	-	-	-	-	-
CO.4	3	2	2	2	-	-	-	-	-	-	-	-
CO.5	3	2	2	2	-	-	-	-	-	-	-	-

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QUESTION BANK

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CO*	3	2	2	2	-	-	-	-	-	-	-	-

Max Marks: 10

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S.No.	CO	Questions	BT
		Unit I: (MULTISTAGE AND DIFFERENTIAL AMPLIFIERS)	
1	1	Draw the circuit of a two-stage RC coupled BJT amplifier and derive the expression for voltage gain, current gain, input impedance and output impedance.	L4
2	1	Explain the operation of a Darlington pair and derive its overall current gain, voltage gain and input resistance.	L2
3	1	Discuss the different coupling schemes (RC, Direct, Transformer) and their frequency applications.	L2
4	1	Analyze the Cascode amplifier configuration and derive gain, input and output resistance expressions.	L2
5	1	a) Classify amplifiers based on different criteria and explain each type with examples. b) List and explain various distortion mechanisms in multistage electronic amplifiers.	L2 L2
6	1	Explain the working of an RC-coupled multistage amplifier and illustrate how the overall voltage gain is calculated when two amplifier stages are cascaded	L3
7	1	Analyze the small-signal operation of a MOS differential pair and derive the expression for differential gain	L4
8	1	Derive differential gain, common-mode gain and CMRR of BJT differential amplifier.	L4
9	1	a) Perform small-signal analysis of MOS differential pair. b) Analyze non-ideal effects in differential amplifier and suggest improvement methods.	L2 L2
10	1	A differential amplifier has a differential gain (A_d) of 2000 and a CMRR of 80 dB. If a differential input signal of V_d = 10 µV and a common-mode signal of V_c = 10 mV are applied, calculate the output voltage Vo and the common-mode gain Ac.	L4

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S.No.	CO	Questions	BT
		Unit II: (FREQUENCY RESPONSE)	
1	2	a) Derive low-frequency response of CE amplifier and determine lower cutoff frequency. b) Derive the expression for upper cutoff frequency of a CE amplifier.	L2
2	2	Explain Miller effect and derive high-frequency gain expression of CE amplifier.	L3
3	2	a) Draw and explain the high-frequency model of a BJT CE amplifier. b) Derive low-frequency response of CS amplifier.	L2 L2
4	2	Explain the high-frequency response of a Common Source amplifier.	L2
5	2	Explain the internal capacitive effects in BJT amplifiers and discuss how they influence the high-frequency response of the amplifier.	L4
6	2	a) Derive low-frequency response of Common Source amplifier. b) A CE amplifier has $C_c = 10\mu F$, $R_{in} = 2k\Omega$. Determine lower cutoff frequency.	L2
7	2	Describe the high frequency response of Common Emitter amplifier and derive the expression of cut-off frequency.	L3
8	2	Evaluate the high-frequency performance of CS and CG amplifiers.	L5
9	2	Analyze the hybrid-π model of CE amplifier at high frequencies.	L4
10	2	a) Describe small signal equivalent model by using Common Emitter amplifier. b) Explain the internal capacitance of MOS transistors.	L3

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S.No.	CO	Questions	BT
		Unit III: (FEEDBACK AMPLIFIERS)	
1	3	a) Explain the general structure of a feedback amplifier and derive the fundamental feedback equation. b) Determine new input resistance for a series–series feedback amplifier where $R_{in} = 2k\Omega$, $A\beta = 50$.	**L2**
2	3	a) Analyze the Series-Shunt (Voltage-Series) feedback topology and derive expressions for voltage gain, input resistance and output resistance. b) Compare the four basic feedback topologies in terms of input and output resistance changes.	**L2** **L2**
3	3	a) Prove that negative feedback improves the stability of gain and reduces nonlinear distortion. b) Derive general expression for closed loop gain with positive feedback.	**L2** **L2**
4	3	a) Analyze the Series-Series (Current-Series) feedback topology and derive the transconductance gain with feedback. b) Derive general expression for closed-loop gain with negative feedback.	**L2** **L2**
5	3	a) Discuss the impact of Shunt-Shunt feedback on the input and output resistances. b) A feedback amplifier has an open-loop gain of 1000 and β= 0.01. Calculate the closed-loop gain and the percentage change in A_f if A changes by 10%.	**L2** **L4**
6	3	a) Explain the operation of a feedback current amplifier (Shunt-Series) with a neat circuit diagram. b) Explain the characteristics of negative feedback amplifier	**L2** **L2**
7	3	An amplifier has a voltage gain of 1000 without feedback. When negative feedback is applied, the gain reduces to 100. 1. Calculate the feedback factor (β). 2. If the open-loop gain increases by 10%, calculate the percentage change in the closed-loop gain.	**L3**
8	3	a) Calculate output resistance reduction for shunt–shunt feedback when $R_o = 10k\Omega$, $A\beta = 100$. b) Derive general expression for closed loop gain with positive feedback.	**L5**

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9	3	a) Briefly discuss the properties of negative feedback amplifier b) Derive the voltage gain expression of feedback voltage amplifier (series-shunt).	L4
10	3	Derive expressions for: Transresistance gain, Input resistance and Output resistance with the help of shunt shunt feedback amplifier.	L3

S.No.	CO	Questions	BT
		Unit IV: (OSCILLATORS AND TUNED AMPLIFIERS)	
1	4	Draw the circuit of a BJT RC Phase Shift oscillator and derive the frequency of oscillation and condition for sustained oscillations.	L2
2	4	Explain the operation of a Wien-Bridge Oscillator and derive the condition for oscillation using the lead-lag network.	L3
3	4	Derive the frequency of oscillation for a Colpitts Oscillator using BJT.	L2
4	4	Analyze the Hartley Oscillator circuit and find the expression for the frequency of oscillation.	L2
5	4	Describe the working of a Single Tuned Amplifier and derive the expression for its 3-dB bandwidth.	L3
6	4	Discuss the operation of a Crystal Oscillator and its equivalent circuit.	L2
7	4	Explain the operation of a UJT Relaxation Oscillator using a circuit diagram.	L2
8	4	a) Describe the working of a double Tuned Amplifier and derive the expression for its 3-dB bandwidth. b) Verify Barkhausen criterion for a given amplifier with gain 30 and feedback 1/30.	L2

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9	4	a) Design a Wien-Bridge oscillator to produce a frequency of 5 kHz. b) Explain the principles and advantages of Stagger Tuned Amplifiers.	L4 L2
10	4	a) Describe the working of a Single Tuned Amplifier and derive the expression for its 3-dB bandwidth. b) For stagger tuned amplifier, two resonant frequencies are 950kHz and 1.05MHz. Determine effective bandwidth.	L2
11	4	In Hartley oscillator, $L_1 = 2mH$, $L_2 = 3mH$, $C = 0.01\mu F$. Find oscillation frequency.	L3

S.No.	CO	Questions	BT
		Unit V: (POWER AMPLIFIERS)	
1	5	Explain the operation of a direct coupled Class A output stage and derive the expression for its maximum power conversion efficiency.	L2
2	5	Explain the operation of a transformer coupled Class A output stage and derive the expression for its maximum power conversion efficiency.	L2
3	5	Analyze the Class B Push-Pull output stage and derive the expression for maximum efficiency	L2
4	5	Discuss the working of a Class AB output stage and explain how it eliminates crossover distortion	L3
5	5	a) Derive power dissipation and efficiency for a Class C amplifier. b) Explain the working principle of class AB power amplifier.	L2 L2
6	5	a) Compare Class A, class B and class C power amplifier. b) What is crossover distortion in Class B amplifier? How can it be reduced.	L2
7	5	a) Differentiate voltage amplifier and power amplifier. b) Explain the working principle of a Class-C amplifier with neat circuit diagram.	L2

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8	5	A Class B push-pull amplifier operates with a supply voltage of V_{CC} = 15V and drives a load of R_L = 8Ω. If the peak output voltage is 12V, calculate: 1. The DC input power (Pdc). 2. The AC output power (Pac). 3. The collector efficiency (η).	**L5**
9	5	Explain the Class B push-pull amplifier with neat diagram. Derive: Maximum efficiency (78.5%), Output power and Crossover distortion.	**L4**
10	5	a) Discuss briefly about a Class C amplifier. b) Write short notes on applications of Class-C amplifier.	**L3**

Note: L1-Remembering, L2-Understanding, L3-Applying, L4-Analyzing, L5-Evaluating, and L6-Creating