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ANNA UNIVERSITY (UNIVERSITY DEPARTMENTS) April/May 2024

B.E. /B.Tech / B. Arch (Full Time) - END SEMESTER EXAMINATIONS,

ELECTRONICS AND COMMUNICATION ENGINEERING

Semester 04

EC5403 Electronic Circuits II

(Regulation 2019)

Time:3hrs Max. Marks: 100

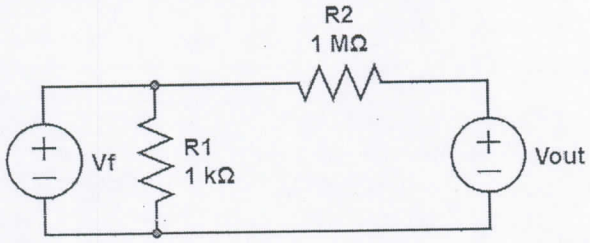
CO1	Ability to design feedback amplifiers and analyze stabilization techniques
CO2	Ability to design Op-amps
CO3	Ability to analyze RC and LC oscillators
CO4	Ability to analyze tuned amplifiers and its stability conditions
CO5	Ability to analyze power amplifiers and DC-DC Converters

BL – Bloom's Taxonomy Levels

(L1-Remembering, L2-Understanding, L3-Applying, L4-Analysing, L5-Evaluating, L6-Creating)

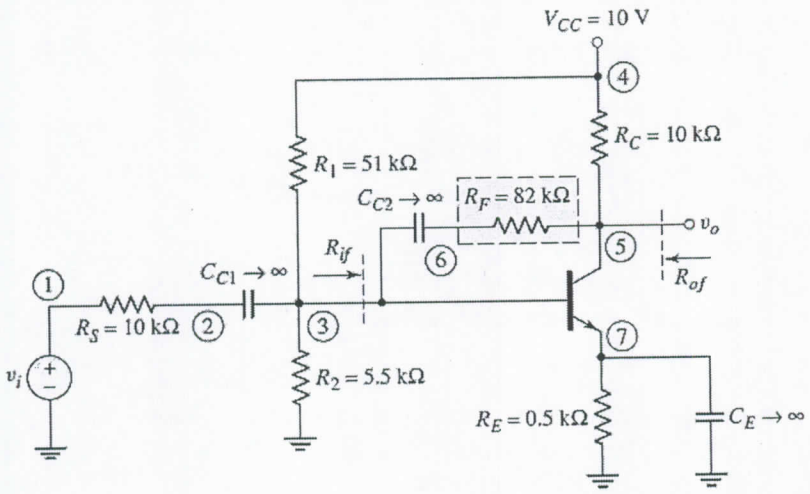
PART- A (10 x 2 = 20 Marks)

(Answer all Questions)

Q. No.	Questions	Marks	CO	BL
1	An amplifier has an open loop gain of $A=10^8$ and an open loop 3 dB bandwidth of 1500 Hz. Calculate the closed-loop bandwidth when the closed-loop gain is $A_f = 50$.	2	1	L3
2	A series-shunt feedback amplifier has a feedback network as shown in Fig. 1. If the open loop gain, input and impedance of the amplifier are 75 dB, 100 kΩ and 700 Ω respectively, find the closed loop gain in dB, input and output impedances.  **Fig. 1**	2	1	L3
3	Give the expression for the overall voltage gain of a two-stage operational amplifier.	2	2	L2
4	Draw the structure of a telescopic OPAMP with current mirror circuit and state its significance.	2	2	L2
5	The stability of the Colpitts oscillator is improved by modifying the feedback network (having $C_1 = 0.1$ μF and $C_2 = 1$ μF) through the addition of a third capacitor of magnitude 100 μF in series with inductor. Suggest a suitable value of inductor to sustain the oscillations at 100 kHz.	2	3	L3
6	Design a Wien bridge oscillator that generates sinusoidal signal at 6.5 kHz. Assume identical lead-lag network with $R_1 = R_2 = 3$ kΩ and $C_1 = C_2$.	2	3	L3
7	A tank circuit is constructed using 100 pF Capacitor and 100 μH inductor. If the coil has a loss resistance of 5 Ω, determine the resonant frequency and circuit impedance at resonance.	2	4	L3

8	Consider the design of an IF amplifier for an FM radio receiver using four synchronously tuned amplifier stages. The 3 dB bandwidth of each stage is 400 kHz. Determine the overall bandwidth of the tuned amplifier.	2	4	L3
9	"The conversion efficiency of a transformer coupled Class A amplifier is 50%" – Justify with relevant formulations.	2	5	L2
10	Evaluate the duty cycle and average output voltage of a step-up converter with T_{ON} = 1.2 ms, T_{OFF} = 0.5 ms and average input voltage of 10 V.	2	5	L3

PART- B (5x 13=65Marks)

Q. No.	Questions	Marks	CO	BL
11 (a)	Identify the feedback topology and estimate the closed loop gain, input and output impedances of the circuit shown in Fig. 2. The transistor parameters are h_{fe} = 100, $V_{BE(on)}$ = 0.7 V, and V_A =∞.  Fig. 2	13	1	L4
	OR			
11 (b)	A feedback current amplifier constructed using NMOS transistors is described in Fig. 3. Calculate the following if the transistors are sized so that at I_D = 0.2 mA they operate at V_{ov} = 0.2 V. Both the devices have V_t = 0.5 V and V_A = 10 V. (a) If I_s has zero dc component, show that both Q1 and Q2 are operating at I_D = 0.2 mA. What is the dc voltage at the input? (b) Find g_m and r_o for each of Q1 and Q2 (c) Find the A circuit and the value of R_i, A and R_o. (d) Find the value of β. (e) Find $A\beta$ and A_f. (f) Find R_{in} and R_{out}	13	1	L4

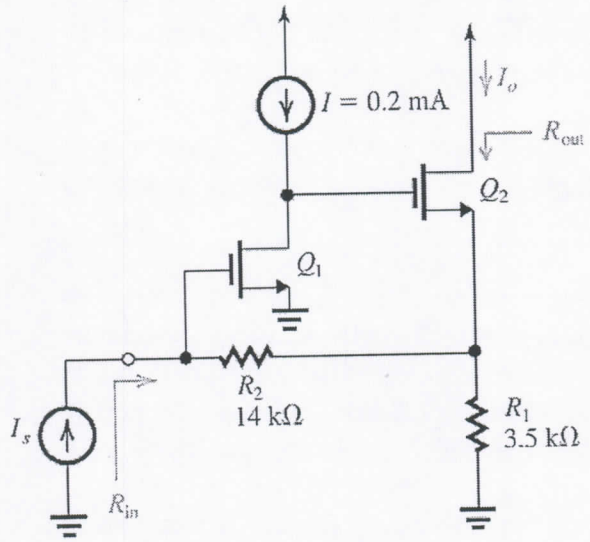
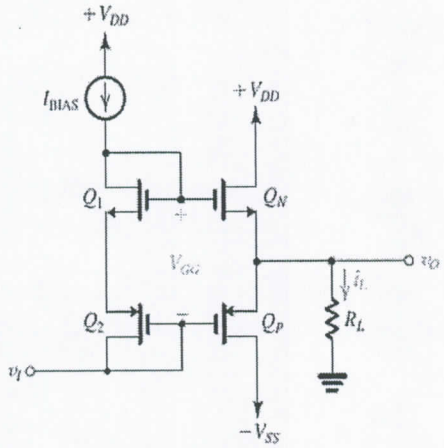


Fig. 3

12 (a)	Design a fully differential telescopic operational amplifier with voltage gain 60 dB using the following specifications: Power supply voltage: 3 V Peak-to-peak differential output voltage swing: 3 V Power dissipation: 10 mW Assume the transistor parameters $\mu_n C_{ox}$ = 60 μA/V², $\mu_p C_{ox}$ = 30 μA/V², λ_n = 0.1 V⁻¹, λ_p = 0.2 V⁻¹ (for an effective channel length of 0.5 μm), γ = 0, and $V_{THN} = \lvert V_{THP} \rvert$ = 0.7 V Also, suggest suitable modifications to the design to tweak the gain of the designed amplifier to 70 dB.	13	2	L4
	OR			
12 (b)	With a neat circuit diagram analyze the operation of a two-stage CMOS based Operational Amplifier in terms of input common mode range, output swing and overall DC voltage gain.	13	2	L4
13 (a)	Describe the construction and operation of an RC phase shift oscillator. Deduce the condition for minimum transistor h_{fe} to obtain sustained oscillations.	13	3	L2
	OR			
13 (b)	(i) With a neat circuit, explain the operation of a Hartley oscillator. Using necessary equivalent circuit, determine the frequency of oscillation and the condition for sustained oscillations. (ii) A Colpitt oscillator has the following parameters. L = 5 μH, C_1 = C_2 = 10 nF. Determine its oscillation frequency. Also, find the change in oscillation frequency when the inductor is varied from L = 5 μH to L = 15 μH.	9+4	3	L2
14 (a)	(i) A single-tuned amplifier is used to amplify the modulated RF carrier of 600 kHz and bandwidth of 15 kHz. The amplifier without tank circuit has a total output resistance of 20 kΩ and	8+5	4	L3

	output capacitance of 50 pF. Determine the value of the inductance and capacitance of the tuned circuit required to make the amplifier functional with the specification described above. (ii) With necessary mathematical formulations, obtain the bandwidth of a single-tuned amplifier with N cascaded sections.			
	OR			
14 (b)	(i) Design and evaluate the results of a FET-based single-tuned amplifier with g_m=5mA/V, r_0=10kΩ, f_0=1MHz, centre frequency gain=-10V/V and 3dB bandwidth=10kHz.Assume c_0 is negligible. Also, evaluate the Q factor. Is the calculated Q factor suitable for communication applications? Justify your answer. (ii) With any two methods, analyze how the stability is achieved in tuned amplifiers using neutralization technique.	**7+6**	**4**	**L3**
15 (a)	(i) Analyze the Class B power amplifier stage in terms of load line characteristics, power dissipation and power conversion efficiency. (ii) For the class AB output stage shown in Fig. 4, consider the case of matched Q_1 and Q_2, and matched Q_N and Q_P. If the quiescent current I_Q=1mA and I_{BIAS}=0.2 mA , find the (W/L) for each of the transistors Q_1, Q_2, Q_N, Q_P so that in the quiescent state, each transistor operates at an overdrive voltage of 0.2V. Let $V_{DD} = V_{SS}$ = 2.5 V, $\mu_n C_{ox}$ = 250 μA/V², $\mu_p C_{ox}$ = 100 μA/V², $V_{THN} = \|V_{THP}\|$ = 0.5 V. Also find V_{GG}.  **Fig. 4**	**9+4**	**5**	**L3**
	OR			
15 (b)	(i) Using relevant switching waveforms, describe the construction and operation of a BUCK converter. (ii) The buck converter with MOS transistor switching has an input voltage of 10 V. If the switching frequency is 1 kHz and the required average output voltage is 5 V, determine the duty cycle, output inductance and capacitance. Assume the maximum ripple voltage and ripple currents are 20 mV and 0.2 mA respectively.	**10+3**	**5**	**L3**

PART- C (1x 15=15Marks)

(Q.No.16 is compulsory)

Q. No.	Questions	Marks	CO	BL
16.	A folded cascode operational amplifier with PMOS load has to be designed to offer a voltage gain of 2000. The specifications of the operational amplifier are: DC power supply voltage of 3 V, differential output swing of 2.4 V, power dissipation of 6 mW. The device parameters are: $\mu_n C_{ox}$ = 60 μA/V^2, $\mu_p C_{ox}$ = 30 μA/V^2, λ_n = 0.1 V^{-1}, λ_p = 0.2 V^{-1} (for an effective channel length of 500 nm), γ = 0, and V_{THN} = 0.3 V, V_{THP} = -0.35 V. Also, find the necessary bias voltages for the NMOS and PMOS pair.	15	2	L6