B.E. ELECTRONICS AND TELE-COMMUNICATION ENGINEERING
SECOND YEAR SECOND SEMESTER EXAM, 2022

ANALOG CIRCUITS- II **Time: Three hours** **Full Marks: 100**

Module I Any one (20)

1. a) Draw a darlington pair emitter follower circuit using npn BJTs. Explain the practical limitations of achieving high input impedance from that circuit. Explain bootstrapping to overcome the problem. [2+3+5]

   b) In Fig. 1 two transistors are identical with h_{ie}=1kΩ, h_{re}=2.5×10^{-4}, h_{oe}=2.5×10^{-5} A/V, h_{fe}=100. Find input resistance, v_{o1}/v_i and v_{o2}/v_i. [10]

2. Determine the 3 dB frequencies and midband gain of a cascode circuit shown in figure 2. The parameters are: $V+$ = 10 V, $V-$ = −10 V, R_S = 100 Ω, R_1 = 42.5 kΩ, R_2 = 22 kΩ, R_3 = 28 kΩ, R_E = 5.6 kΩ, R_C =5 kΩ, R_L = 10 kΩ, and C_L =1 pF. The transistor parameters are: β = 150, V_{BE}(on) =0.7 V, V_A =∞, C_{C1} = C_{C2} = C_B=0.1 μF, and C_E = 5 μF, $C\pi$ = 5 pF, and $C\mu$ = 14 pF. [20]

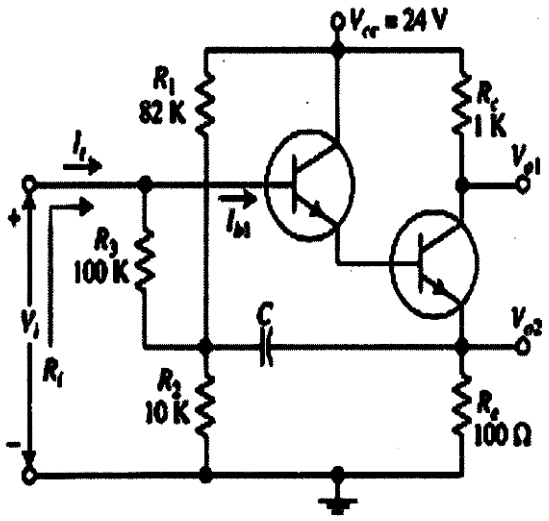

Figure 1

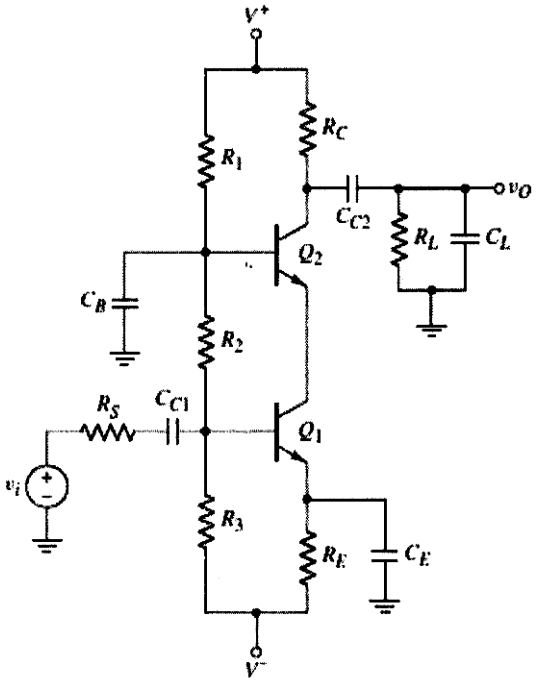

Figure 2

Module II Any three (3×10=30)

3. The class-A power amplifier is biased at V_{DD}=10 V, R_D=5 kΩ, K_n = 5 mA/V^2,V_{TN} = 1 V, and λ = 0. Calculate the actual maximum power conversion efficiency of the amplifier in Figure 3. Assume the output voltage swing is limited to the range between the saturation and cut-off to minimize nonlinear distortion. Cut-off voltage is 9.4 V. Explain why is the efficiency much less than its theoretical maximum value. [I_{Dsat} = $K_n(V_{GS} - V_{TN})^2$] [10]

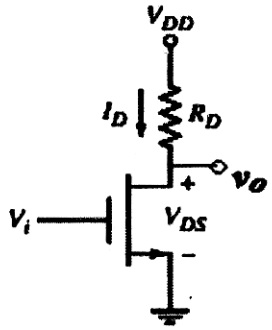

Figure 3

4. Explain nonlinear distortions in a transistor amplifier? Obtain the expression for output if the dynamic characteristic is given by a parabolic form ($A_0x+B_0x^2$), where A_0 and B_0 are constants and input is sinusoidal. Derive the form of 2nd order harmonic distortion and mention its importance. [4+6]

5. Classify tuned amplifiers. Why can't amplifiers be used at low frequencies? What are the advantages of double tuned amplifier? What is stagger tuning? The bandwidth of a double-tuned amplifier is 10 KHz. Calculate the number of such stages to be connected to obtain the bandwidth of 5.098 KHz. [10]

6. Draw and explain class AB push-pull power amplifier. [10]

Module III Any one (1×5=5)

7. Derive the expression for voltage gain of the amplifier with voltage-mixing voltage-sampling feedback topology. [5]

8. Draw a current sampling voltage mixing circuit and calculate the input resistance of the closed loop network in which voltage gain is 100, input resistance is 5 kΩ and output resistance is 8 kΩ in open-loop condition. Feedback ratio β=1 V/A. [5]

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Module IV Any two (2×15=30)

9. Draw a monostable multivibrator circuit using 555 timer IC and explain its working principle with the help of its internal circuit diagram. Find the value of external components so that the unstable state sustains for 10 msec. *(Assume the SR flip-flop used in the IC is a positive edge trigger FF and the IC is using a 5V supply voltage).* Draw the trigger waveform, capacitor voltage and corresponding output waveforms to scale. [8+7]

10. Derive the basic principle of oscillation. Draw and explain Wien-Bridge Oscillator. Derive the expression of the frequency of oscillation. [3+6+6]

11. a) What are the advantages of crystal oscillator over LC oscillators. Draw equivalent circuit of a piezoelectric crystal. Draw a crystal oscillator circuit in series-resonant mode using BJT. [2+2+2]

    b) Explain the operation and derive the frequency of oscillation of Hartley oscillator using Op-Amp. [9]

Module V Any one (1×5=5)

12. With the help of block diagram briefly explain the operation of PLL. [5]

13. With the help of appropriate diagram explain capture range and lock range. [5]

Module VI Any One (10)

14. Design an audio amplifier (only gain stage) to deliver an average power of 0.1 W to an 8 Ω speaker from a microphone that produces a 10 mV peak sinusoidal signal and has a source resistance of 1 kΩ. V_{CC}=12V, β = 100. Consider I_{C1} =5mA and I_{C2}=15mA. [10]

15. Design a function generator that can generate sine, square and triangular wave. Choose proper components to obtain the frequency of the sine wave as 5 kHz. [10]