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UNIVERSITY OF SWAZILAND

FACULTY OF SCIENCE

DEPARTMENT OF ELECTRONIC ENGINEERING

MAIN EXAMINATION 2005

TITLE OF PAPER: **ELECTRONICS I** **(Paper I)**

COURSE NUMBER: **E360**

TIME ALLOWED: THREE HOURS

INSTRUCTIONS: ANSWER **QUESTION 1** AND ANY OTHER **THREE QUESTIONS**

QUESTION 1 CARRIES 40 MARKS

QUESTION 2, 3, 4, AND 5 CARRY 20 MARKS EACH.

MARKS FOR DIFFERENT SECTIONS ARE SHOWN IN THE RIGHT-HAND MARGIN

THIS PAPER HAS 6 PAGES, INCLUDING THIS PAGE

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Question 1

a). Figure 1.A shows an electronic circuit used in a ship steering system. Determine the expression for the voltage v_m supplied to the motor in terms of the command voltage v_c and the feedback voltage v_f. (7 marks)

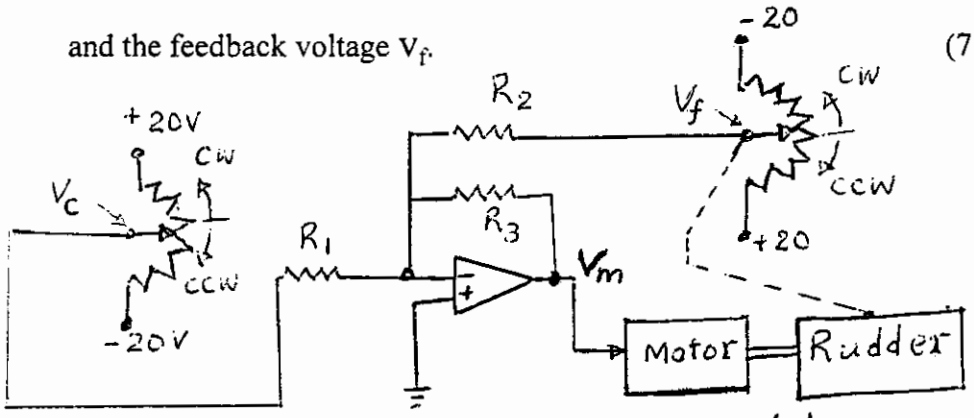

Figure 1 A

b) How is stabilization achieved in a self-biasing circuit? (4 marks)

c) In Figure 1.C, find the percentage change in the collector current if the current gain β is decreased by 50%. (10 marks)

d) In the circuit shown in Figure 1.D , Q1 and Q2 are identical transistors having $r_\pi = 2k\Omega$ and $g_m = 0.1\ \Omega^{-1}$

i) Draw the equivalent circuit diagram (4 marks)

ii) Find the input and output impedances, and the transfer ratio (12 marks)

iii) State which type of basic amplifier this circuit approximate and draw it. (3 marks)

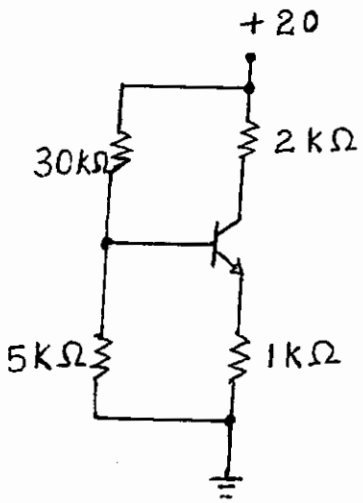

Figure 1 C

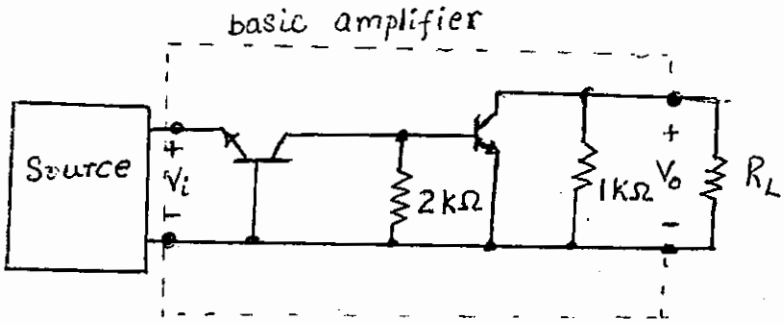

Figure 1 D.

Question 2

A fixed bias, common emitter, single stage amplifier is to have the following requirements:

1. voltage gain Av = - 60
2. Input impedance Ri = 1.9937Ω (as seen by the source)
3. Output impedance Ro = 12kΩ (as seen by the load resistor)
4. A 1 K resistor and a bypass capacitor are to be connected to the emitter of the transistor
5. The transistor when biased at room temperature have $r_\pi = 2k\Omega$, $g_m = 2k\Omega$ and a thermal voltage of 25 millivolts.
6. A capacitor C_1 couples the amplifier to the source and a capacitor C_2 couples the amplifier to the load resistor R_L.

If this amplifier is to be supplied by a 9 battery then

(a) draw the circuit diagram and the equivalent circuit at midband . (5 marks)

(b) obtain the following resistor values: base resistor R_B, collector resistor R_C and load resistor R_L. (6 marks)

(c) obtain the Q-point voltages and currents (I_{CQ}, I_{BEQ}, V_{BEQ}, and V_{CEQ}) (9 marks)

Question 3

For the circuit shown in Figure 3, determine the open-loop gain A_{OL}, feedback transfer ratio β return ration T, and closed-loop gain A_F. (20 marks)

The BJT parameters are $g_m = 0.02$ and $r_\pi = 10k$

The FET parameters are $\mu = 40$ and $r_{ds} = 10k$

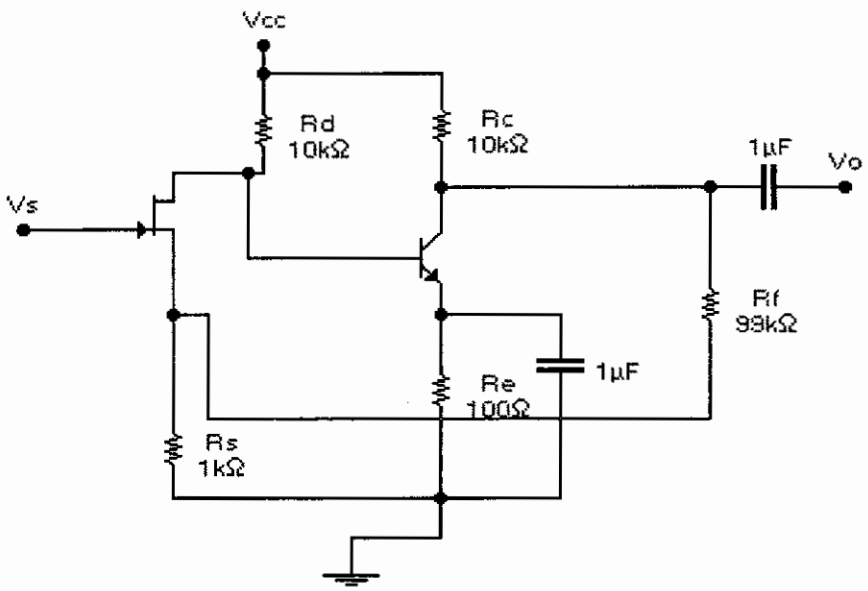

Figure 3

Question 4

a) State two conditions which must be satisfied by a circuit to sustain oscillation (4 marks)

b) A phase shift oscillator shown in Figure 4 has a return ratio given by

$$T(j\omega_n) = \frac{jA_v\omega_n^3}{1-6\omega_n^2 + j\omega_n(5-\omega_n^2)}$$

Where $\omega_n = \omega RC$.

The FET has $g_m = 0.04\Omega^{-1}$ and $r_{ds} = 1k\Omega$.

Obtain

(i) the frequency of oscillation in Hz [4 marks]

(ii) the gain of the JFET [7 marks]

(iii)the return ratio at the frequency of oscillation [5 marks]

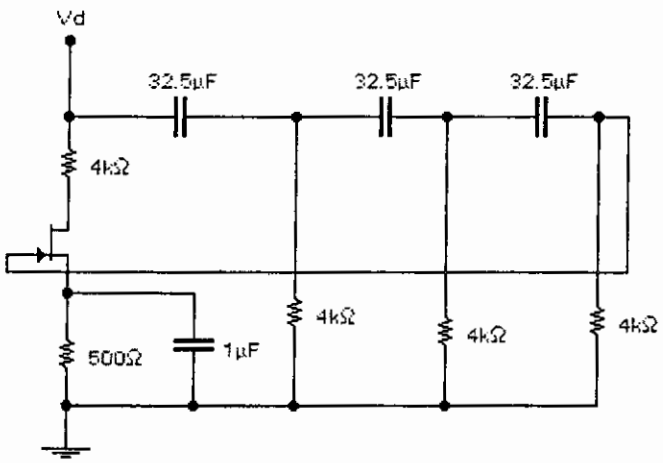

Figure 4

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Question 5

For a simple transformer coupled class A power amplifier shown in Figure 5,

Vi = 0.02 sin(2000πt), $h_{fe} = \beta = 100$, hie = 100 Ω, and VBE = 0.6 V.

Obtain

a) the power supplied by 12 volts dc supply [6 marks]

b) the ac output power [10 marks]

c) the conversion efficiency [2 marks]

d) the power dissipated in the transistor [2 marks]

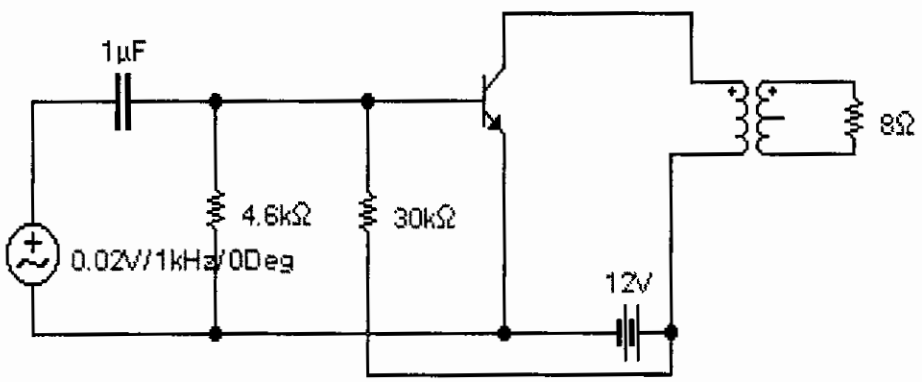

Figure 5