MACHAKOS UNIVERSITY

University Examinations for 2022/2023 Academic Year

SCHOOL OF ENGINEERING AND TECHNOLOGY

DEPARTMENT OF ELECTRICAL AND ELECTRONIC ENGINEERING

THIRD YEAR FIRST SEMESTER EXAMINATION FOR

BACHELOR OF SCIENCE (ELECTRICAL AND ELECTRONIC ENGINEERING)

EEE 308: ANALOGUE ELECTRONICS I

DATE: **TIME:**

INSTRUCTIONS

Answer question **ONE** and **ANY OTHER TWO** questions

QUESTION ONE (COMPULSORY) (30 MARKS)

a) Calculate the dynamic forward and reverse resistance of a PN junction Germanium diode, given that the applied voltage is 0.25 V, I_o = 1 μA and T = 300^o K.

(6 marks)

b) Derive the relationship between base current amplification factor β and emitter current amplification factor α.

(6 marks)

c) The measured values of a diode at a junction temperature of 27°C are given by

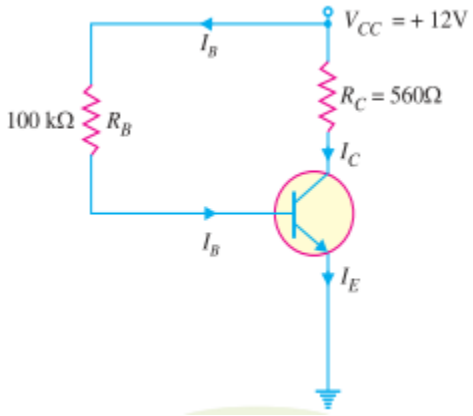
$$V_D = \begin{cases} 0.5\text{ V} & \text{at } I_D = 5\ \mu\text{A} \\ 0.6\text{ V} & \text{at } I_D = 100\ \mu\text{A} \end{cases}$$

Determine

i. the emission coefficient η and
ii. the leakage current I_S.

(6 marks)

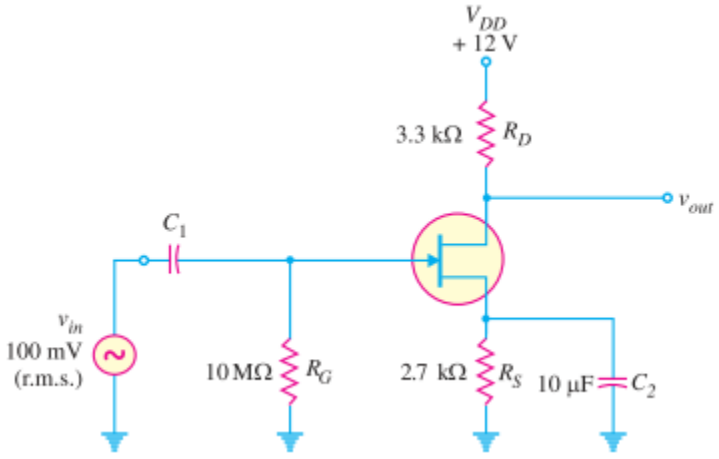
d) A base reistor bias circuit in FigQ1 (d) is subjected to an increase in temperature from 25°C to 75°C. If ß = 100 at 25°C and 150 at 75°C, determine the percentage change in Q-point values (V_{CE} and I_C) over this temperature range. Neglect any change in V_{BE} and the effects of any leakage current.



FigQ1 (d)

(8 marks)

e) What is the r.m.s. output voltage of the unloaded amplifier in FigQ1 (e) given that I_{DSS} =8 mA, $V_{GS(off)}$ = -10 V and I_D = 1.9 mA?



FigQ1 (e)

(4 marks)

QUESTION TWO (20 MARKS)

a) An NPN transistor with $\beta = 50$, is used in Common Emitter circuit with $V_{CC} = 10V$ and $R_C = 2\ k\Omega$. The bias is obtained by connecting a 100 $k\Omega$ resistance from collector to base. Assume $V_{BE} = 0$ V. Find
   i. The Quiescent Point;
   ii. The Stability Factor.

(4 marks)

b) One NPN transistor is used in the potential divider biasing arrangement. The circuit components values are Vcc = 4.5V, $R_C = 1.5\ k\Omega$, $R_E = 0.27\ k\Omega$, $R_2 = 2.7\ k\Omega$ and $R_1 = 27\ k\Omega$. If $\beta = 44$. Find the
   i. Stability Factor;
   ii. Quiescent point Q.

(4 marks)

c) Derive the expression for stability factor S for potential divider method of biasing.

(8 marks)

QUESTION THREE (20 MARKS)

a) Given that $V_{CC} = +12$ V, $R_B = 240\ k\Omega$ and $R_C = 2.2\ k\Omega$ determine the following for a common emitter transistor using fixed bias configuration
   i. I_{BQ} and I_{CQ};
   ii. V_{CEQ};
   iii. V_B and V_C;
   iv. V_{BC}.

(6 marks)

b) For the network of Fig.Q4 (b)
   i. Determine I_{CQ} and V_{CEQ};

ii. Find V_B, V_C, V_E and V_{BC}.

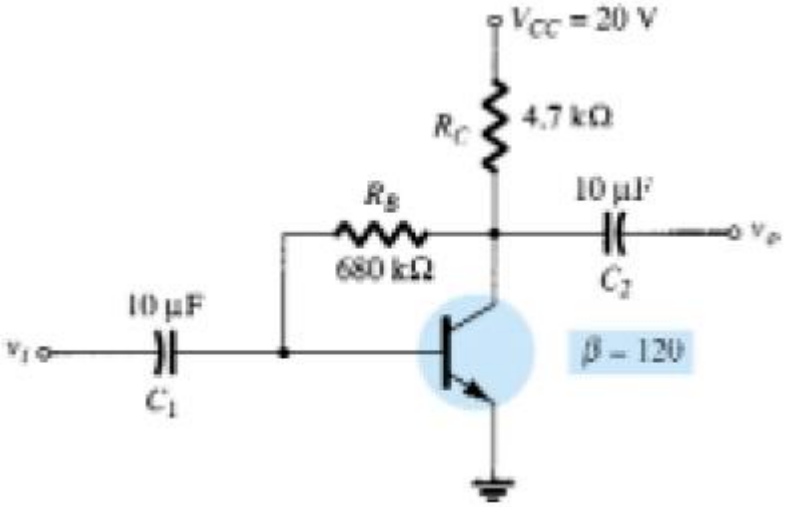


Fig.Q4 (b)

(7 marks)

c) Determine the dc bias voltage V_{CE} and the current I_C for CE amplifier using the voltage-divider configuration and having the following parameters: V_{CC} = +22 V, R_C = 10 kΩ, R_E = 1.5 kΩ, R_2 = 3.9 kΩ and R_1 = 39 kΩ and β = 140.

(7 marks)

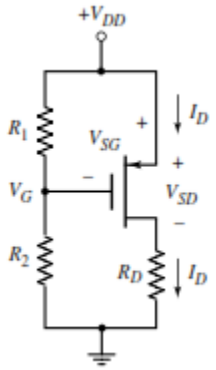
QUESTION FOUR (20 MARKS)

a) FigQ4 (a) shows a p-channel enhancement-mode MOSFET circuit. Calculate

i. the drain current $I_{D;}$

ii. source-to-drain voltage $V_{SD.}$

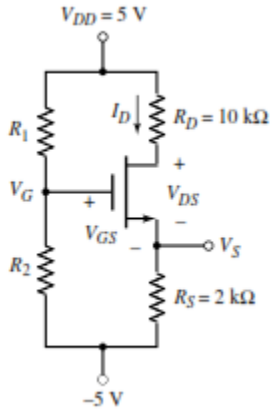
Assume that $R_1 = R_2$ = 50 kΩ, V_{DD} = 5V, R_D = 7.5 kΩ, V_{TP} = -0.8 v, and K_p = 0.2mA/V^2.



FigQ4 (a)

(10 marks)

(b) For the dc circuit in FigQ4 (b), assume that the MOSFET parameters are V_{TN} = 2 V, k'_n = 80 μA/V^2, and W/L = 4. Choose R_1 and R_2 such that the current in the bias resistors is approximately one-tenth of I_D. Design the circuit such that I_D = 0.5 mA.



FigQ4 (b)

(10 marks)

QUESTION FIVE (20 MARKS)

a) Determine the following for the network in Fig.Q5 (a)

i. I_{DQ} and V_{GSQ};

ii. V_D.

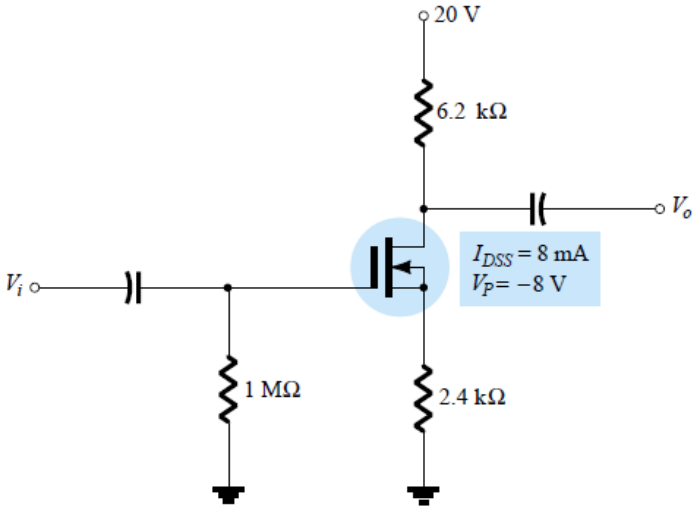


Fig.Q5 (a)

(8 marks)

b) The following readings were obtained experimentally from a JFET:

V_{GS}	0V	0 V	- 0.2 V
V_{DS}	7 V	15 V	15 V
I_D	10 mA	10.25 mA	9.65 mA

Determine

i. A.C. drain resistance;
ii. Trans-conductance;
iii. Amplification factor.

(8 marks)

c) In an n-channel JFET biased by potential divider method, it is desired to set the operating point at I_D = 2.5 mA and V_{DS} = 8 V. If V_{DD} = 30 V, R_1 = 1 MΩ and R_2 = 500 kΩ, find the value of R_S. The parameters of JFET are I_{DSS} = 10 mA and $V_{GS(off)}$ = - 5 V.

(4 marks)