INSTRUCTION(S) TO CANDIDATES

DO NOT OPEN UNTIL YOU ARE ASKED TO DO SO

• A total mark of this examination is 100.
• This examination is worth 50% of the total assessment.
• Answer ALL FIVE (5) questions.
• Useful formula and necessary parameters are given in page 6.

Any form of cheating or attempt to cheat is a serious offence which may lead to dismissal.
Q.1 [20 marks]
(a) The MOSFET circuit is shown in Fig. 1, the transistor parameters are 
\( K_n = 0.5 \text{ mA/V}^2, \ V_{TN} = 0.8\text{V} \) and \( \lambda = 0 \). Find \( V_{GS}, \ I_D, \) and \( V_{DS} \). Also calculate the small-signal hybrid-\( \pi \) parameters \( g_m \) and \( r_0 \).  

(b) The BJT amplifier circuit is shown in Fig. 1(b), the transistor parameters are \( \beta = 100 \) and \( V_A = 100 \). (i) Determine \( I_{CQ} \) and \( V_{CEQ} \) (ii) find the small-signal hybrid-\( \pi \) parameters \( r_n, g_m \) and \( r_0 \).
Q.2 [20 marks]

Draw the small signal equivalent circuit diagram of the MOSFET amplifier which is shown in Fig. 2 and find followings; (20 marks)

(i) the input resistance $R_i$,
(ii) the voltage gain $A_v = \frac{V_o}{V_s}$ and
(iii) the output resistance $R_o$ of the amplifier at midband frequencies. The transistor parameters are $g_m=0.65$ mA/V and $r_o = 100$ kΩ.

![Fig. 2](image)

Q.3 [20 marks]

(a) Draw the Bode plot (magnitude and phase) of the following transfer function. (8 marks)

$$H(s) = \frac{10^6 s(s + 10)}{(s + 100)(s + 1000)}$$

(b) The common emitter transistor amplifier is shown in Fig. 3(b) and the transistor has small signal hybrid-π parameters, $r_x = 2.5$ kΩ, $g_m= 40$ mA/V and $r_o = \infty$.

(i) Determine the value of $C_C$ such that the lower 3dB/corner frequency is 15Hz.
(ii) Find the maximum current gain $|A|_{dB}$ in dB, where $A = \frac{i_o}{i_s}$. (12 marks)

![Fig. 3(b)](image)
Q.4 [20 marks]

(a) A BJT is biased at $I_C = 0.15$ mA, and has parameters $\beta_0 = 150$, $C_\pi = 0.8\text{pF}$ and $C_\mu = 0.12\text{pF}$. Determine beta cutoff frequency $f_\beta$ and cutoff frequency $f_I$.

(5 marks)

(b) The common emitter amplifier is shown in Fig. 4(b) which is operated at high frequencies. The transistor parameters are: $r_\pi = 3 \text{k}\Omega$, $g_m = 40 \text{mA/V}$ and $r_o = \infty$, $C_\pi = 25 \text{pF}$, and $C_\mu = 2 \text{pF}$.

(15 marks)

(i) Draw the high-frequency equivalent circuit diagram.

(ii) Draw the Miller equivalent circuit diagram.

(iii) Find the Miller capacitance.

(iv) Find the upper 3 dB/corner frequency ($f_{Hf}$) without Miller capacitance,

(v) Find the upper 3 dB/corner frequency ($f_{Hf}$) with Miller capacitance,

(vi) Find the upper 3 dB/corner frequency ($f_{Hf}$) with load capacitance, $C_L$ and

(vii) Find the midband voltage gain.

Q.5 [20 marks]

(a) State 5 advantages and 2 disadvantages of a negative feedback amplifier.

(5 marks)

(b) The open-loop low-frequency voltage gain of an amplifier is $A_V = 5 \times 10^4$ and the open-loop 3 dB frequency is $f_H = 10\text{Hz}$. If the closed-loop gain is $A_{gf} = 25$, what is the closed-loop bandwidth?

(5 marks)
(c) A series-series feedback amplifier topology is shown Fig. 5(c). Draw the ideal equivalent circuit diagram and find the closed loop transconductance gain, $A_{gf}$, the input resistance, $R_{if}$ and output resistance $R_{of}$.

(10 marks)
## USEFUL FORMULA

<table>
<thead>
<tr>
<th>BJT</th>
<th>MOSFET</th>
</tr>
</thead>
<tbody>
<tr>
<td>$i_C = I_s e^{v_{xe}/v_T} \cdot \left( 1 + \frac{v_{CE}}{V_A} \right)$</td>
<td>$g_m = 2 \sqrt{K_n I_{DQ}}$</td>
</tr>
<tr>
<td>$g_m = \frac{I_{CO}}{V_T}$</td>
<td>$r_o = \frac{1}{\lambda I_{DQ}}$</td>
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<tr>
<td>$r_o = \frac{V_A}{I_{CO}}$</td>
<td>$K_n = \frac{k_n}{2} \left( \frac{W}{L} \right)$</td>
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<tr>
<td>$V_T = 26 \text{ mV}$</td>
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<tr>
<td>$V_{BE\ (on)} = 0.7 \text{ V}$</td>
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