الجامعة الإسلامية العالمية ماليزيا
INTERNATIONAL ISLAMIC UNIVERSITY MALAYSIA
يونيورسيتي إسلام انتارابغسا ملايسيا

KULLIYYAH OF ENGINEERING

END OF SEMESTER EXAMINATION
SEMESTER II, 2014/2015 SESSION

Programme	: **Engineering**	Level of Study	: **UG 2**
Time	: **2.30 pm -5.30 pm**	Date	: **02/06/2015**
Duration	: **3 Hrs**		
Course Code	: **ECE 2133**	Section(s)	: **1-2**
Course Title	: **Electronic Circuits**		

This Question Paper Consists of **7 (Seven)** Printed Pages (Including Cover Page) with **5 (Five)** Questions.

INSTRUCTION(S) TO CANDIDATES

DO NOT OPEN UNTIL YOU ARE ASKED TO DO SO

- Total mark of this examination is **100.**
- This examination is worth **50 %** of the total course assessment.
- Answer **ALL QUESTIONS.**
- Only approved calculator with 'KoE approved' sticker is allowed (non-programmable and non-graphical).
- Marks assigned to each problem are listed in the margins.

Any form of cheating or attempt to cheat is a serious offence which may lead to dismissal.

All electronics gadgets are prohibited in the exam hall / venue.
(e.g. mobile / smart phones, smart watches, and smart glasses)

QUESTION 1 (20 marks)

(a) Define transfer function of an amplifier. Find the transfer function of the circuit shown in **Fig. 1(a)** and its the corner frequency. What should be the maximum gain of the circuit? (10 marks)

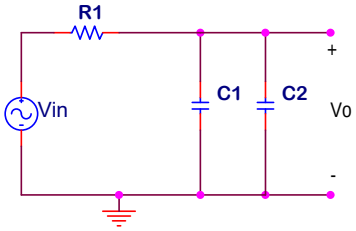

Fig. 1(a)

(b) Draw the frequency response curves, magnitude and phase of the following transfer function by applying Bode plot. (10 marks)

$$H(s) = \frac{10^6(s+50)}{s(s+1)(s+500)}$$

QUESTION 2 (20 marks)

Draw the small signal equivalent circuit diagram of circuit shown in **Fig. 2** which is operating in the midband region of frequencies**.** The circuit parameters are: R_1 = 60 kΩ, R_2 = 40 kΩ, R_E = 0.4 kΩ, R_L = 10 kΩ, C_{C1} = 10μF, C_{C2} = ∞ and C_L = 10pF. The transistor has small-signal hybrid-π parameters, r_π = 3 kΩ, g_m = 40mA/V and r_o = 100 kΩ.

Analyze the circuit by finding the followings:

(i) The input resistance, R_i. (2 marks)

(ii) The output resistance, R_o. (5 marks)

(iii) The small signal midband current gain, . $A_i = \frac{i_o}{i_i}$ (5 marks)

(v) The upper corner frequency due to C_{C1} = 10 μF. (3 marks)

(v) The upper corner frequency due to C_L = 10 pF. (3 marks)

(vii) The bandwidth of the amplifier. (2 marks)

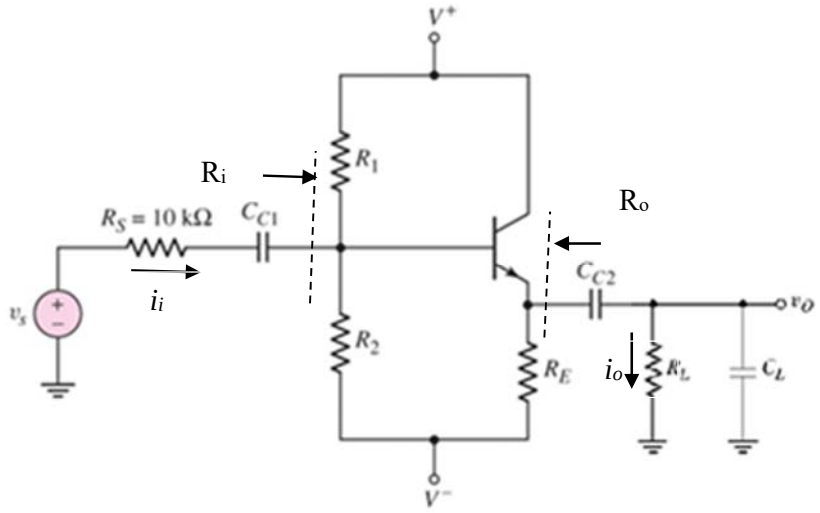

Fig. 2

QUESTION 3 (20 marks)

a) Draw a small signal high frequency equivalent circuit diagram of a short circuited MOSFET amplifier shown in **Fig. 3(a)**. Analyze the circuit step by step and find the short circuit current gain, $A_i = \frac{i_o}{i_i}$ of the amplifier. What should be the unity gain frequency, f_T of the amplifier?

(10 marks)

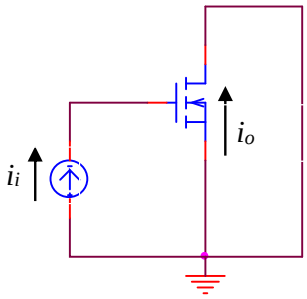

Fig. 3 (a)

b) A common emitter amplifier is shown in **Fig. 3 (b)** that operates at high frequencies. The circuit parameters are: R_s = 2 kΩ, R_1 = 33 kΩ, R_2 = 22 kΩ, R_E = 4 kΩ, R_C = 4 kΩ R_L = 5 kΩ, C_{C1} = 1μF, C_E = 10μF and C_L = 10pF. The transistor parameters are: g_m = 40 mA/V r_π = 3 kΩ and r_o = 100 KΩ, C_π = 10 pF and C_μ = 3 pF.

(i) Draw the simplified high-frequency small signal equivalent circuit diagram. (2 marks)

(ii) Evaluate the value of Millar capacitance. (4 marks)

(iii) Evaluate the upper 3dB frequency (f_H) considering Miller capacitance (2 marks)

(iv) Evaluate the upper 3dB frequency (f_H) without considering Miller capacitance. (2 marks)

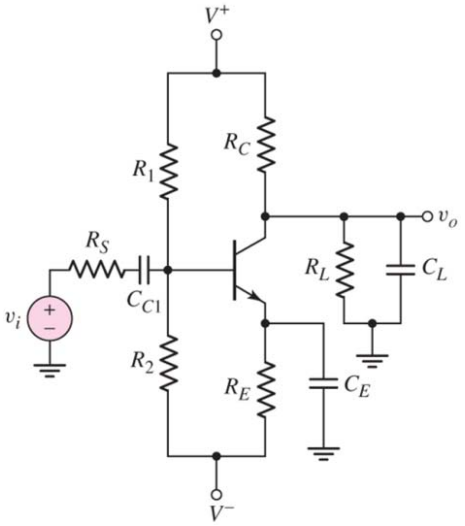

Fig. 3(b)

QUESTION 4 (20 marks)

a) Design a three transistor current source as shown in **Fig. 4(a)** such that $I_O = 2$ mA. What is the value of I_{REF}? The transistor parameters are: V_{BE} (on) = 0.7 V, β = 100 and $V_A = \infty$. (5 marks)

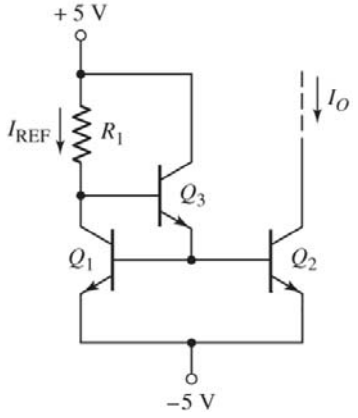

Fig. 4(a)

b)

(i) Design a MOSFET current source as shown in **Fig. 4(b)** such that I_R = 25 mA, I_o = 10mA, and $V_{DS2(sat)}$ = 0.3 V. The biasing voltages $+V_{DD}$ = +5 V and $-V_{DD}$ = -5 V. The transistors are available with parameters: $k_n' = 60\mu A/V^2$, V_{TN} = 0.4 V and λ = 0.

(5 marks)

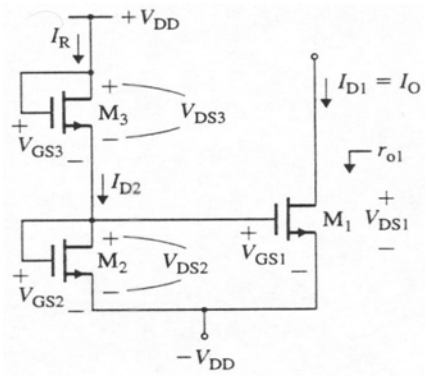

Fig. 4(b)

(ii) Design a new current source using only BJT by converting the MOSFETs.

(2 marks)

c) The open-loop low-frequency gain of a shunt series amplifier is A= 5×10^4 and the closed-loop gain is A_f = 25. The open-loop amplifier input resistance, R_i = 10 KΩ and the output resistance, R_o = 100 Ω, what is the value of the input resistance, R_{if} and output resistance R_{of} of the closed loop amplifier? What is the value of open loop amplifier bandwidth if the closed loop amplifier bandwidth is 500MHz? (8 marks)

QUESTION 5 (20 marks)

a) Draw the block diagram and small signal equivalent circuit diagram of a series-series feedback amplifier and identify the amplifier type. Analyze step by step the feedback amplifier by finding the closed loop gain, A_f, the input resistance, R_{if} and the output resistance R_{of} in terms of open-loop amplifier parameters. (10 marks)

b) Consider the differential amplifier shown in **Fig. 5(b)** with the transistor parameters $\beta = 150$, V_{BE} (on) = 0.7 V and $V_A = \infty$. Design the circuit such that the Q-point values are $I_{C1} = I_{C2} = 100\ \mu A$ and $v_{o1} = v_{o2} = 1.2$ V for $v_1 = v_2 = 0$ V. (5 marks)

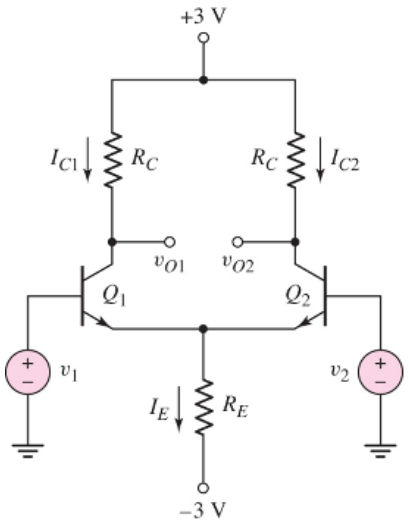

Fig. 5(b)

c) A differential amplifier has a differential mode gain of $A_d = 100$ and the common-mode rejection ratio CMRR = 250. Find the differential amplifier output v_o if the input voltages of the differential amplifiers are $v_1 = 200\,\text{mV}$ and $v_2 = 100\,\text{mV}$ (5 marks)

USEFUL FORMULA

BJT	MOSFET
$i_C = I_S e^{v_{BE}/V_T} \cdot \left(1 + \frac{v_{CE}}{V_A}\right)$ $g_m = \frac{I_{CQ}}{V_T}$ $r_\pi = \frac{\beta V_T}{I_{CQ}}$ $r_o = \frac{V_A}{I_{CQ}}$ $V_T = 26\,\text{mV}$ $V_{BE}(on) = 0.7\text{V}$	$I_D = \frac{1}{2} k_n' \left(W/L\right)(V_{GS} - V_T)^2 (1 + \lambda V_{DS})$ $g_m = 2\sqrt{K_n I_{DQ}}$ $r_o = \frac{1}{\lambda I_{DQ}}$ $K_n = \frac{k_n'}{2}\left(\frac{W}{L}\right)$

END OF PAPER