KULLIYYAH OF ENGINEERING

END OF SEMESTER EXAMINATION
SEMESTER II, 2016/2017 SESSION

Programme	: **Engineering**	Level of Study	: **UG 2**
Time	: **2:30 pm -5:30 pm**	Date	: **23/05/2017**
Duration	: **3 Hrs**		
Course Code	: **EECE 2313/ECE 2133**	Section(s)	: **1-3**
Course Title	: **Electronic Circuits**		

This Question Paper Consists of **6 (Six)** 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)

Q.1 [20 marks]

(a) Consider the circuit shown in **Fig. 1(a)**, derive the expression (step by step) for the voltage transfer function, $T(s) = {v_o(s)}/{v_i(s)}$. Find the corner frequency of the circuit if C_{S1} = 30 μF, C_{S2} = 60 μF and R_p = 60 kΩ. (8 Marks)

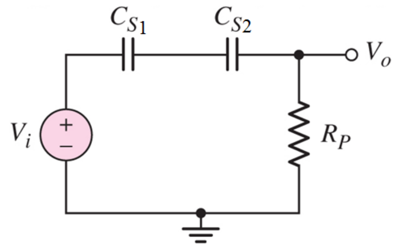

Fig. 1(a)

(b) Draw the Bode plot (magnitude and phase) of the following transfer function. (8 Marks)

$$T(s) = 10^6 \frac{s(s+50)(s+500)}{(s+100)}$$

(c) Determine the magnitude and phase of the transfer function from the plots drawn for **Q1(b)** at frequency ω = 200 radian/sec. (4 Marks)

Q.2 [20 marks]

(a) The common source amplifier as shown in **Fig. 2(a)** with the following circuit component values R_{si} = 10 kΩ, R_1 = 234 kΩ, R_2 = 166 kΩ, R_S = 0.5 kΩ, R_D = 4 kΩ, R_L = 20 kΩ. The MOSFET has small-signal hybrid-π parameters, g_m = 2 mA/V and $r_o = \infty$.

Design the amplifier circuit that operate at lower corner frequency, f_L = 300 Hz and upper corner frequency, f_H = 300 kHz. Determine the maximum gain of the designed amplifier in dB? (10 Marks)

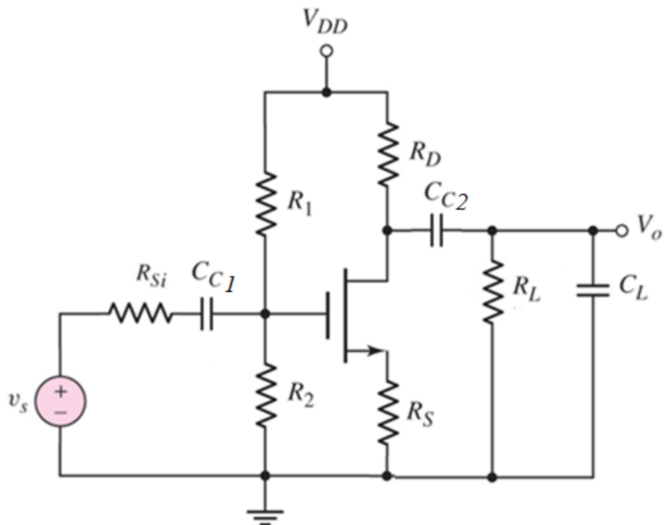

Fig. 2(a)

(b) A common emitter amplifier is shown in **Fig. 2 (b).** It operates at very high frequencies. Consider the transistor parameters of the transistor are: g_m = 40 mA/V, r_π = 3 kΩ and r_o = 100 KΩ, C_π = 8 pF and C_μ = 2 pF.

(i) Draw the simplified high-frequency small signal equivalent circuit diagram and Miller equivalent circuit diagram. (3 marks)

(ii) Write the expression of Miller capacitance and find its value. (3 marks)

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

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

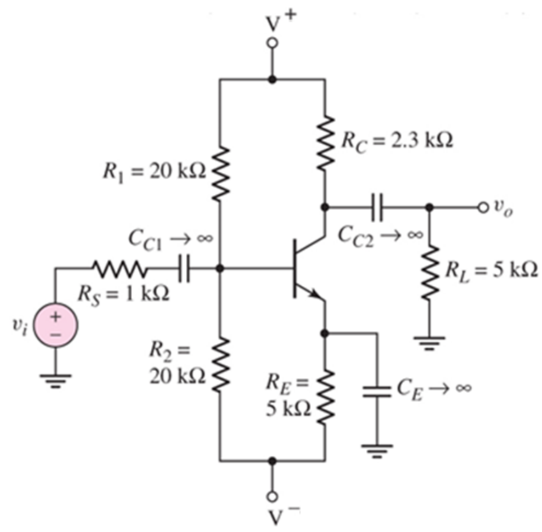

Fig. 2(b)

Q.3 [20 marks]

(a) (i)The circuit diagram of a Wildar current source is shown in **Fig. 3(a)**. Step by step derive the relationship between I_{REF} and I_o by neglecting base currents. (9 marks)

(ii) Design the Wildar current source to produce I_o = 20μA for I_{REF} = 100μA by neglecting the base currents. Also determine the V_{BE2}

[Given that V^+ = 3.3 V, V^- = -3.3 V, V_{BE1} = 0.7 V and $V_A = \infty$] (3 marks)

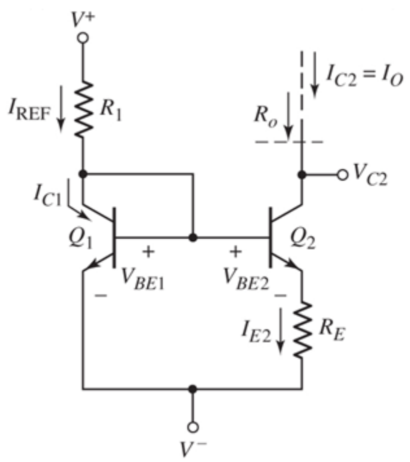

Fig. 3(a)

(b) A multitransistor current source is shown in **Fig. 3(b)**. Design a current source such that I_R = 10 mA and I_{O1} = 5 mA and I_{O2} = 20 mA by assuming M_3, M_4 and M_5 are identical. The transistor parameters are $k_n' = 100 \mu A / V^2$, V_{TN} = 0.8 V and $\lambda = 0$. (6 marks)

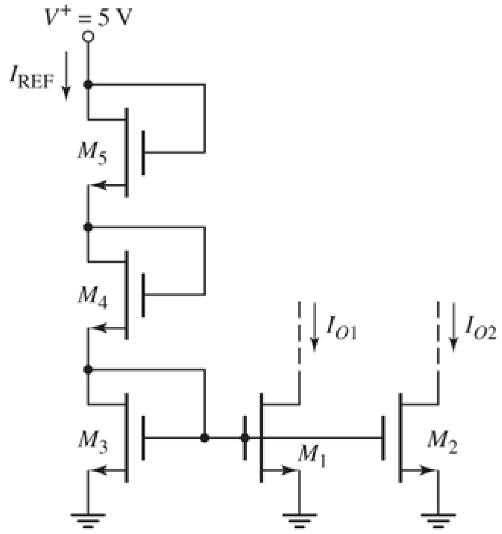

Fig. 3(b)

(ii) Draw the small signal equivalent circuit diagram of the current source shown in **Fig. 3(b).** (2 marks)

Q.4 [20 marks]

(a) Define feedback system with a schematic diagram. (2 marks)

A negative feedback amplifier has a closed loop gain of A_f = 100 and an open loop gain of $A = 5 \times 10^4$. (6 marks)

(i) Determine the feedback transfer function β.

(ii) What should be the closed loop bandwidth if the open loop bandwidth is 5 kHz?

(b) Draw the block diagram and small signal equivalent circuit diagram of a series-series ideal feedback amplifier. Analyze step by step the feedback amplifier to find the expression of the closed loop gain, A_f, the input resistance, R_{if} and the output resistance, R_{of} in terms of open-loop amplifier gain, A and feedback amplifier gain, β. (12 marks)

Q.5 [20 marks]

(a) A phase-shift RC oscillator is shown in **Fig. 5(a)**. Derive the transfer function of the feedback network, $\beta(s) = \dfrac{v_f(s)}{v_o(s)}$. Derive the frequency of oscillation, f_o. Also find the minimum amplifier gain for sustained oscillations. (16 Marks)

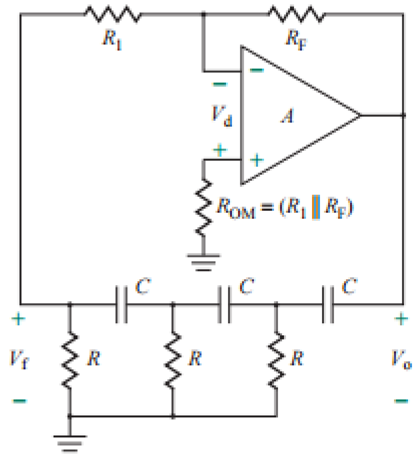

Fig. 5(a)

(b) Design the phase shift oscillator as shown in **Fig. 5(a)** so that the oscillation frequency is $f_o = 1$ kHz. (4 Marks)

USEFUL FORMULA

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

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