INTERNATIONAL ISLAMIC UNIVERSITY MALAYSIA

KULLIYYAH OF ENGINEERING

END OF SEMESTER EXAMINATION
SEMESTER I, 2016/2017 SESSION

Programme	: **Engineering**	Level of Study	: **UG 2**
Time	: **2:30 pm -5:30 pm**	Date	: **23/05/2016**
Duration	: **3 Hrs**		
Course Code	: **ECE 2133**	Section(s)	: **1**
Course Title	: **Electronic Circuits**		

This Question Paper Consists of **7 (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) Draw the Bode plot (magnitude and phase) of the following transfer function. (marks 3+3)

$$T(s) = \frac{1}{150}\frac{(s+15)(s+400)}{s\,(s+250)}$$

(b) Determine the magnitude and phase of the transfer function from the plots drawn in Q.1(a) at a frequency, $s = 300$ radian/sec. (marks 2+2)

(c) A common emitter amplifier circuit as shown in **Fig. 1(c)** has $\beta = 90$ and $r_\pi = 1.5$ kΩ

i. Draw the small-signal AC equivalent circuit. (marks 2)

ii. Determine the input and output resistances of the amplifier (marks 3+2)

iii. Calculate the corner frequencies (marks 3)

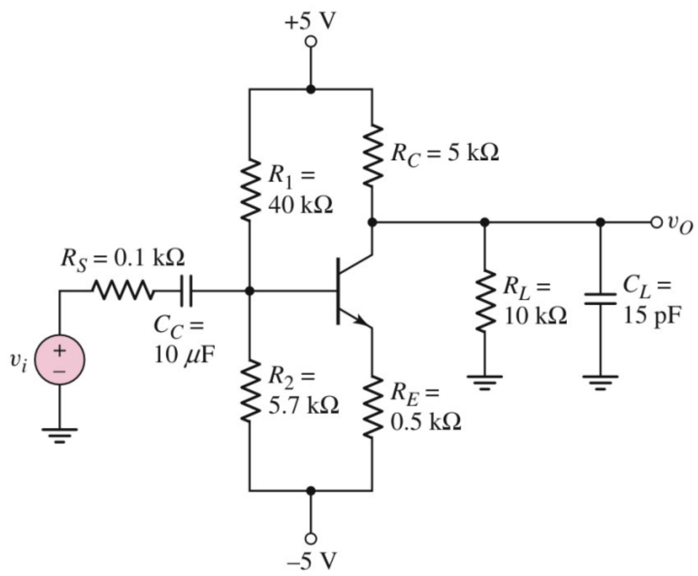

Fig. 1(c)

Q.2 [20 marks]

(a) Draw the simplified small-signal high-frequency equivalent circuit of **Fig. 1(a)**.

(marks 2)

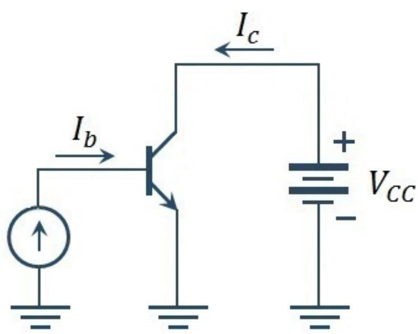

Fig. 1(a)

(b) Determine the transistor short-circuit beta frequency, f_β and cutoff frequency, f_T using the simplified small-signal high-frequency equivalent circuit of **Fig. 1(a)**.

(marks 8)

(c) A simplified small signal high-frequency transistor amplifier model is shown in **Fig. 2(c)**. The transistor parameters are, $r_\pi = 1.5\ k\Omega, \beta = 150, r_0 = 80\ k\Omega,\ C_\pi = 20\ pF$ and $C_\pi = 10\ pF$. If the circuit parameters are, $R_S = 1.5\ k\Omega,\ R_B = 15\ k\Omega, R_C = 15\ k\Omega$ and $R_C = 10\ k\Omega$ then determine the followings:

i. The Miller capacitor value (marks 6)

ii. -3dB higher corner frequency (marks 4)

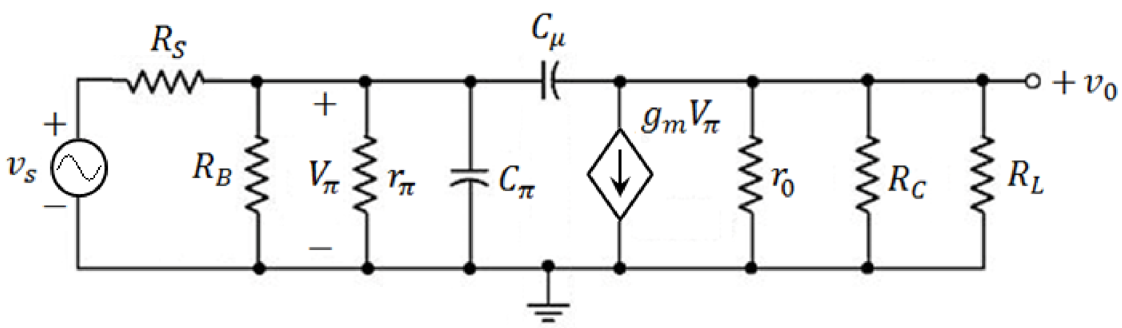

Fig. 2(c)

Q.3 [20 marks]

(a)

i. Design a modified basic current source as shown in **Fig. 3(a)** to give an output resistance $R_0 = 45\ M\Omega$. All the transistors are identical and their parameters are, $g_m = 60\ mA/V$, $r_\pi = 2.5\ k\Omega$, and $V_A = 150\ V$ respectively. The circuit parameters are, $V_{CC} = 40\ V$, $V_{BE1} = V_{BE2} = V_{BE3} = 0.7\ V$ and $V_{CE2} = 25\ V$ respectively.

(marks 3)

ii. Determine the collector current ratio of the circuit, $\frac{I_{C2}}{I_{C1}}$. (marks 3)

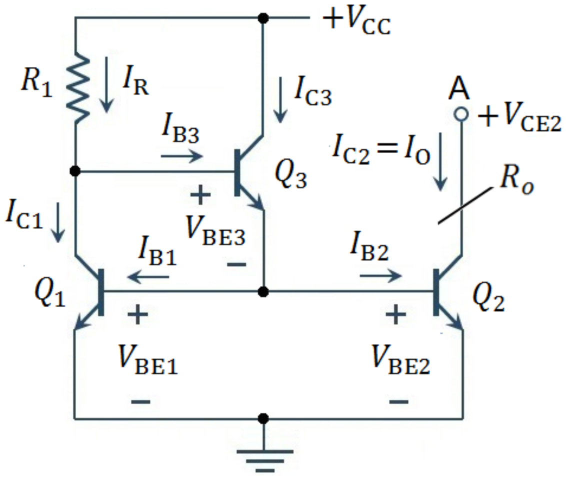

Fig. 3(a)

(b) Deduce the following expressions step by step for MOSFET current source as shown in **Fig. 3(b)**. Assuming all the MOSFETs are identical.

i. MOSFETs parameter ratio, K_{n3}/K_{n2} (marks 2.5)

ii. Output resistance, R_0 (marks 2.5)

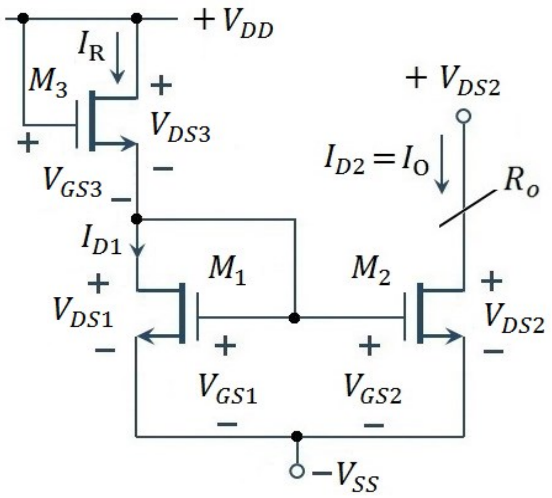

Fig. 3(b)

iii. Design an integrated MOSFET current source as shown in **Fig. 3(b)** for output current $I_0 = I_{D1} = I_{D2} = 10$ µA and output resistance $R_0 = 30$ MΩ. All the MOSFETs are identical and their threshold voltage $V_{t1} = V_{t2} = V_{t3} = 0.5$ V. Assume that the supply voltage, $V_{DD} = 30$ V, $V_{DS1} = 15$ V and $V_{GS1} = 10$ V. (marks 3+3+3)

Q.4 [20 marks]

(a) What are the merits and demerits of the negative feedback amplifier? (marks 4)

(b) Prove that gain sensitivity of an amplifier is improved with negative feedback. (marks 4)

(c) The open loop gain of a voltage amplifier is changed from 1000 to 850 due to temperature effects. Design a negative feedback system to improve the gain stability 1.5% by determining the feedback factor β. (marks 4)

(d) The feedback voltage, v_{fb} and the error voltage v_ε of a series-shunt amplifier are 1.5 V and 100 µV respectively. The close-loop voltage gain of the amplifier is, $A_{vf} = -300$ and the input and output resistances of the original amplifier are $R_i = 10$ kΩ and $R_0 = 1.5$ kΩ respectively.

i. Determine the open-loop gain and feedback factors of the circuit. (marks 4)

ii. Determine the input and output resistances of the amplifier after feedback. (marks 4)

Q.5 [20 marks]

(a) What are the conditions for oscillation? (marks 2)

(b) A wine bridge oscillator circuit as shown in **Fig. 5(b)**, derive the equations

i. The loop gain of the circuit for sustaining oscillation (marks 7)
ii. Frequency of oscillation (marks 7)

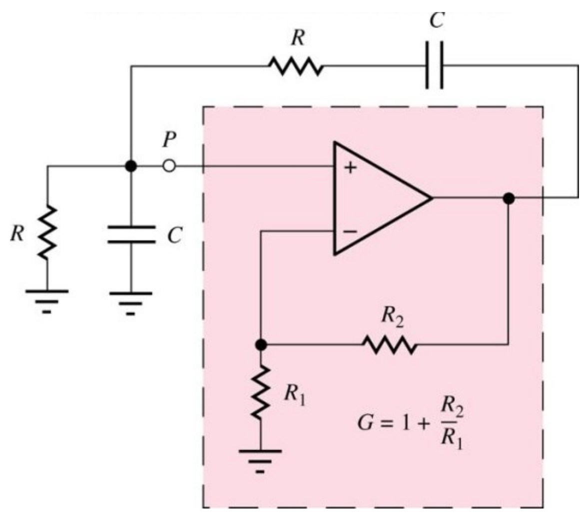

Fig. 5(b)

(c) Design a wine bridge oscillator for generating 1.5 kHz. Assume that the capacitor value is 0.22μF. (marks 4)

USEFUL FORMULA

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

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