American University of Beirut
Faculty of Engineering and Architecture
Department of Electrical and Computer Engineering
ELEG 042 - Analog Electronics
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Quiz 1
November 2001

Closed Book
Programmable Calculators Are Not Allowed.

Time: 1.5 hours

Name:_____ ID#:_____

► Provide your answer on the *computer card only*.
► Return the computer card attached to the question sheet.
► Use a pencil for marking your answers and ID number on the computer card.
► When using an eraser, make sure you erased well.
► On this sheet, write with a pen your name followed by your ID number.
► All questions are equally graded.
► *Only the computer card will be considered in grading.*

PENALTY is FOUR to ONE

Penalty is calculated as follows:
One to three wrong answers result in no penalty; four to seven wrong answers result in canceling one correct answer; eight to eleven wrong answers result in canceling two correct answers; and so on.

Assume in all problems that:
$|V_{BE}| = 0.7$ V
$V_T = 25$ mV
$\beta = 100$ unless otherwise specified
Capacitors are very large
Early effect and body effect are negligible unless otherwise specified

In the circuit of Figure 1, $I_2 = I_3 = 0.24$ mA.

1. Find the collector current of transistor Q_2 in mA.
a) 1.21 b) 0.667 c) 0.242 d) 0.828 e) 0.354

2. Find the collector current of transistor Q_1 in μA.
a) 2.4 b) 12 c) 6.6 d) 8.2 e) 3.5

3. Find the input resistance at the base of Q_2 (R_{i2}) in KΩ.
a) 3.75 b) 2.06 c) 10.3 d) 3.02 e) 7.07

4. Find the input resistance at the base of Q_1 (R_i) in MΩ.
a) 0.758 b) 0.610 c) 0.417 d) 1.43 e) 2.08

5. Find the voltage gain v_{c2}/v_{b2} (v_{c2} and v_{b2} are the small-signal collector and base voltages of transistor Q_2, respectively.)
a) –138.7 b) –475.4 c) –261.5 d) –95.1 e) –324.9

6. Find the voltage gain v_o/v_i
a) –68.4 b) –236.7 c) –46.6 d) –161.5 e) –129.8

7. Find the output resistance R_o in Ohms.
a) 116.8 b) 125.9 c) 164.2 d) 194.3 e) 132.9

In the circuit of Figure 2, assume the DC value of the output voltage to be $V_O = -2$ V.
The MOSFET parameters are $V_{tn} = 0.8$ V, ½ $k'_n(W/L)_n = 0.5$ mA/V^2, $\lambda_n = 0.01$ V^{-1}, and $V_{tp} = -0.8$ V, ½ $k'_p(W/L)_p = 0.2$ mA/V^2, $\lambda_p = -0.01$ V^{-1}.

8. Find V_{GS} for transistor Q_2 in Volts.
a) 1.86 b) 1.66 c) 2.03 d) 1.41 e) 2.18

9. Find I_D of Q_1 in mA.
a) 0.139 b) 0.205 c) 0.105 d) 0.0687 e) 0.172

10. Find the voltage gain v_o/v_{g2} (v_{g2} is the small-signal voltage at the gate of Q_2.)
a) 0.862 b) 0.846 c) 0.820 d) 0.873 e) 0.766

11. Find the voltage gain v_o/v_i
a) –9.65 b) –8.26 c) –6.37 d) –10.8 e) –11.7

In the circuit of Figure 3, assume $I = 250$ μA and $R_B = 30$ K.

12. Find the value of R_E (in KΩ) to get the specified I when $v_1 = v_2 = 0$.
a) 37.1 b) 30.9 c) 92.9 d) 61.9 e) 46.4

13. Find $A_d = v_{o2} / v_d$ when $v_1 = +v_d/2$ and $v_2 = -v_d/2$
a) 49.8 b) 31.1 c) 39.3 d) 45.2 e) 53.4

14. Find $A_{cm} = v_{o2}/v_{cm}$ when $v_1 = v_2 = v_{cm}$
a) –0.664 b) –0.531 c) –0.266 d) –0.796 e) –0.398

15. Find the CMRR in dB, corresponding to the values of the gains calculated in the previous two questions.
a) 41.4 b) 37.5 c) 36.5 d) 38.6 e) 39.9

16. Find the differential input resistance v_d / i_{b1} in KΩ, when $v_1 = +v_d/2$ and $v_2 = – v_d/2$.
a) 127.3 b) 100.4 c) 161 d) 110.5 e) 93.7

17. Find the common-mode input resistance $v_{cm}/(2i_{b1})$ in MΩ, when $v_1 = v_2 = v_{cm}$
a) 3.14 b) 9.42 c) 4.71 d) 6.28 e) 3.77

18. Find the input bias current in μA.
a) 0.743 b) 1.238 c) 0.495 d) 0.990 e) 1.485

19. Find the input offset current (in nA) when β is matched to within +/- 1.5%.
a) 22.3 b) 37.1 c) 29.7 d) 14.9 e) 44.6

A differential amplifier has a differential voltage gain of 350 and a CMRR of 85 dB. A differential input signal of $v_d = 2 \sin(\omega t)$ mV is applied, along with a common-mode voltage of $v_{cm} = 2 \sin(\omega t)$ V. Assume that the common-mode gain is positive.

20. Determine the amplitude of the ideal output voltage in Volts.
a) 0.7 b) 0.6 c) 0.3 d) 0.5 e) 0.4

21. Determine the amplitude of the actual output voltage in Volts.
a) 0.528 b) 0.638 c) 0.422 d) 0.739 e) 0.317

In the circuit of Figure 4, assume Vcc = 7 V.

22. Find the collector current of the BJT in mA.
a) 1.71 b) 1.49 c) 1.26 d) 0.811 e) 1.04

23. Find the value of r_e for the BJT in Ohms.
a) 23.9 b) 30.5 c) 16.7 d) 19.6 e) 14.5

24. Find the input resistance R_i in KΩ.
a) 148.4 b) 142.4 c) 145.8 d) 137.9 e) 131.4

25. Find minimum value of the <u>total</u> output voltage in Volts when $v_s = \sin(\omega t)$ Volt.
a) 2.076 b) 1.624 c) 2.529 d) 0.725 e) 1.174

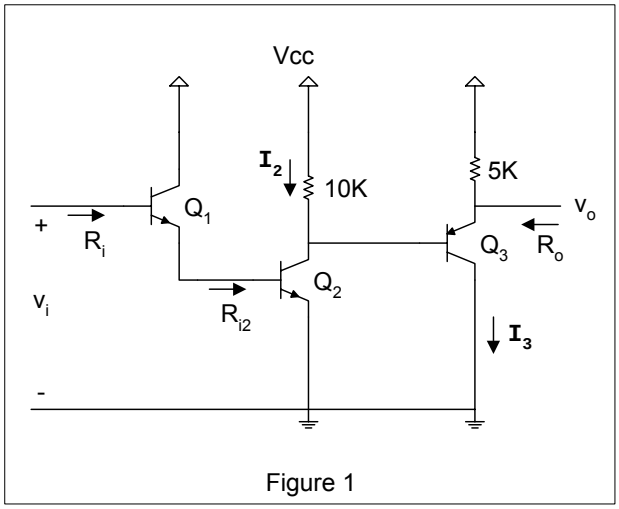

Figure 1

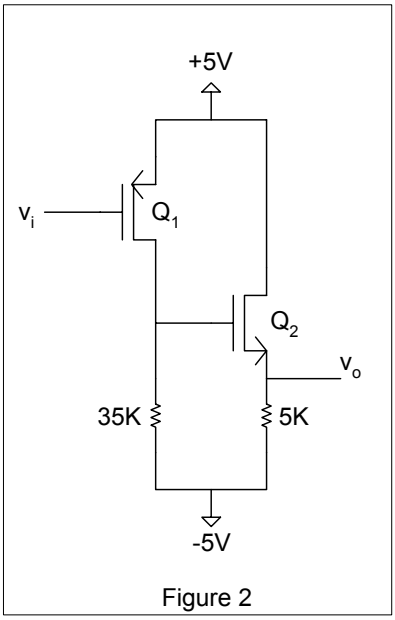

Figure 2

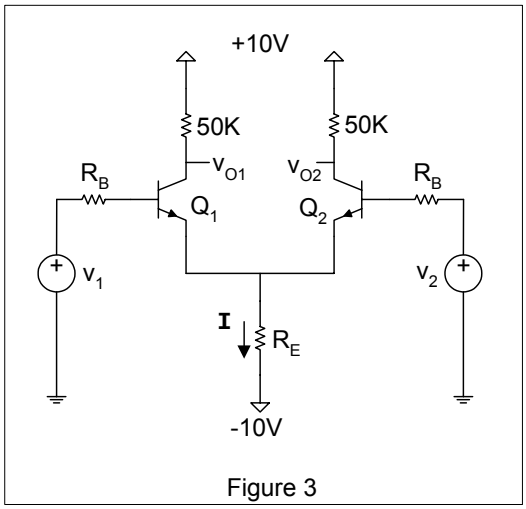

Figure 3

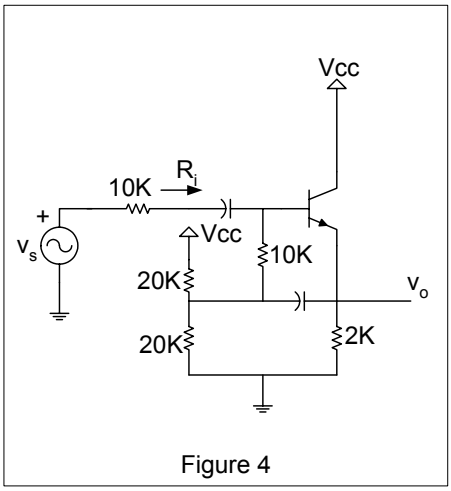

Figure 4