

Bar Code

Electronic Circuits for Mechatronics (ELCT 609)
Spring Semester 2016
Mid-term Exam

Instructions: **Read Carefully Before Proceeding.**

- 1- No programmable/storing calculators, book or other aids are permitted for this test.
- 2- Write your solutions in the space provided. If you need more space, write on the back of the sheet containing the problem.
- 3- **Answer all questions.**
- 4- Read all the problems carefully before starting, and start with the easiest question you find.
- 5- This exam booklet contains **13** pages, including this one., This exam consists of **FOUR** questions
- 6- When you are told that time is up, stop working on the test.
- 7- Total time allowed for this exam is **120 min.**

Good Luck!

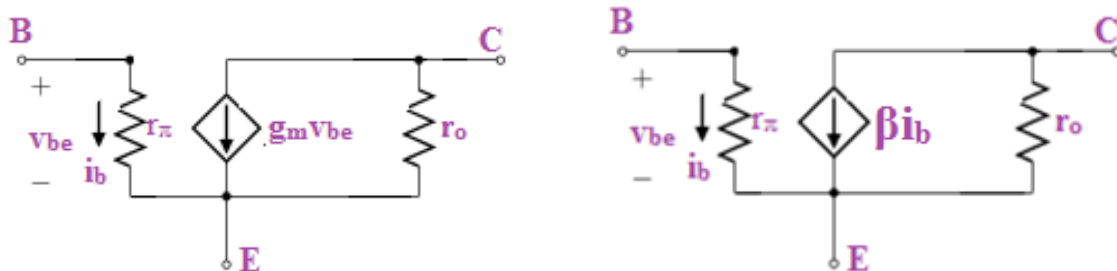
Question Number	1	2	3	4	Total
Maximum Score	20	20	30	35	105
Obtained Score					

Formula Sheet

■ BJT: Modes of Operation

Mode	I-V Characteristics
Cutoff	$I_C = I_E = I_B = 0$
Active (Forward)	$V_{BE} = 0.7V, I_E = I_C + I_B, I_C = \beta_F I_B$
Saturation	$V_{CE} = 0.2V, I_E = I_C + I_B$
Reverse Active	$V_{BC} = 0.5V, I_C = I_E + I_B, I_E = \beta_R I_B$

■ BJT: Small Signal Model

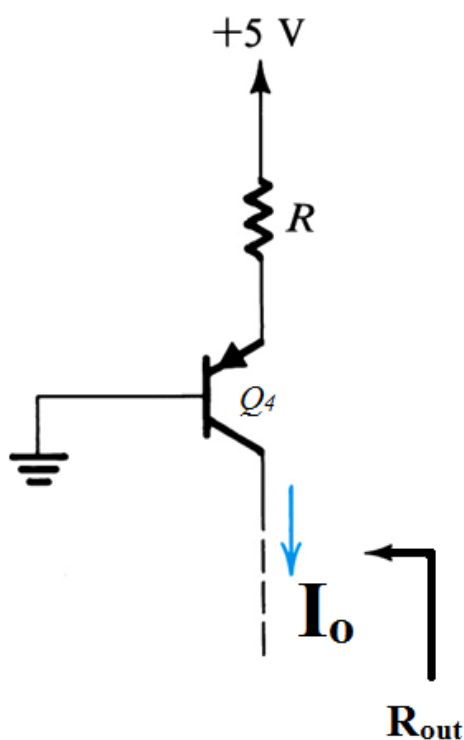
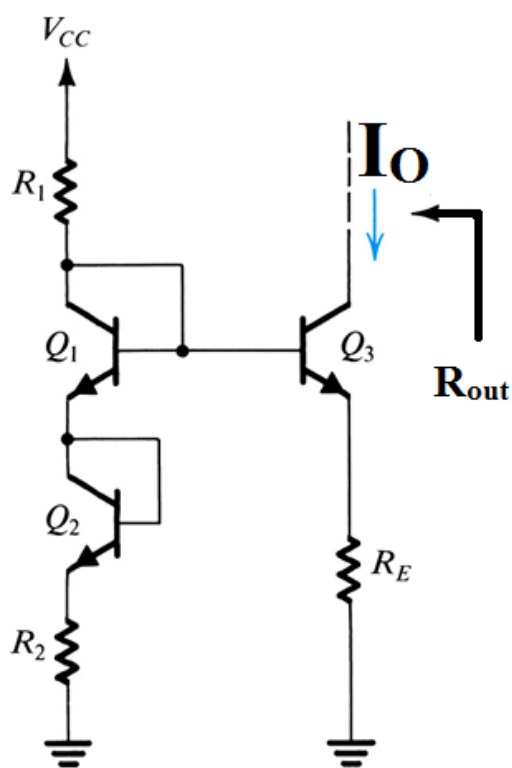


$$g_m = \frac{I_C}{V_T}, r_{\pi} = \frac{\beta}{g_m}, r_o = \frac{V_A}{I_C}, V_T = 25\text{mV}$$

Problem 1: (20 marks)

The two circuits shown are current sources, find their Output current I_o and their output resistance R_{out} .

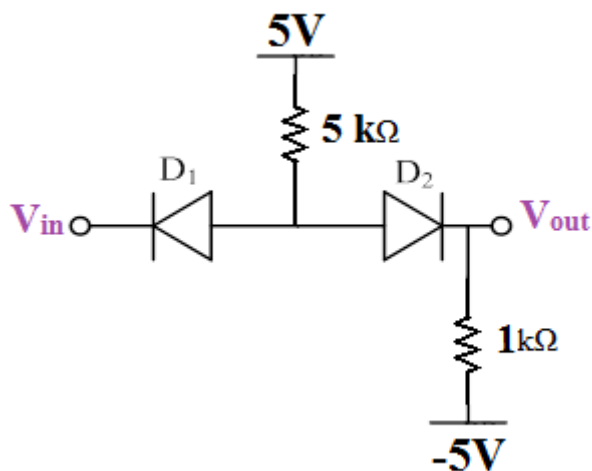
$V_{CC}=10V$, V_{BE} or $V_{EB}=0.7V$, $\beta_F=100$, $R_1=R_2=R_E=1k\Omega$, $R=2.15k\Omega$
(**Hint:** Assume that ALL Transistors are active, Draw the small signal model to calculate the output resistance)



Problem 2: (20 marks)

D1 and D2 are ideal diodes, ' V_{in} ' is a sinusoidal signal with 1 kHz frequency and amplitude voltage of 10V, Analyze the circuit to:

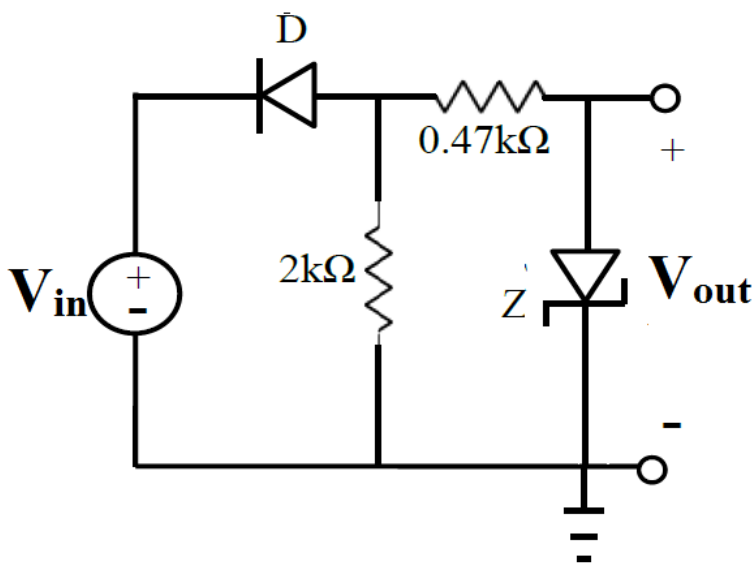
- A. Plot ' V_{out} ' versus ' V_{in} '
- B. Plot ' V_{out} ' versus Time



Problem 3: (30 Marks)

In the circuit shown, the Zener diode has $V_Z = 6.8V$ and $r_Z = 20\Omega$ while the normal diode D has $V_{th} = 0.7V$. The input voltage ' V_{in} ' is a 20-V peak-to-peak sinusoidal signal with an average value of 0V.

- Derive an expression for the output signal ' V_{out} ' over the range of ' V_{in} '
- Sketch ' V_{out} ' versus ' V_{in} '



Problem 4 (35 marks)

For the Common Collector amplifier shown, $V_{BE}=0.7V$, $\beta_F=100$ calculate:

1. The voltage gain ' V_{out}/V_{in} '
2. The Input Resistance ' R_{in} '
3. The Output Resistance ' R_{out} '

