Final Answers Only

Ryerson University
Department of Electrical and Computer Engineering
ELE404 (Electronic Circuits I)
Midterm Examination (W2015)
February 2015
Duration: 100 minutes
Examiner: Prof. A. Yazdani

Name:.....
[Print Last Name] [Print First Name]

Student No:..... Section:....

NOTES

1. This is a closed-book examination. No aids other than basic calculators are permitted.

2. Including this page, the **examination paper has 20 pages**. It is your responsibility to **check the integrity of your examination paper and immediately notify the invigilators of any missing pages.**

3. **DO NOT DETACH ANY PAGES** from the examination paper.

4. The examination consists of **FIVE QUESTIONS**, *each* question is worth as indicated in the following Table. The entire examination is worth *100* marks.

Question #	Maximum Mark	Mark Earned
1	**30**	
2	**10**	
3	**25**	
4	**15**	
5	**20**	
Total	**100**	

5. Answer all questions within the blank spaces provided under each question in this examination paper or on a page marked as "Blank Page" in the examination paper.
Do Not Use the Reverse as it will not be marked.

6. *If in doubt about any question, clearly state your assumptions in answering the question.*

7. Part marks for an answer will only be given if the *correct methodology* is clearly shown.

Q1: In the circuit of **Fig. 1**, D_1 and D_2 are Light-Emitting Diodes (LED) that exhibit a constant voltage drop of 2.5 V when they are *on.*, while they require a minimum forward voltage of 2.2 V (i.e., the cut-in voltage) to start to glow. $R_1 = 1.5\ k\Omega$, $R_2 = 1.0\ k\Omega$, $V_{CC} = 10V$, and $I = 4.0\ mA$. Assume that the reverse breakdown voltages of the diodes are large.

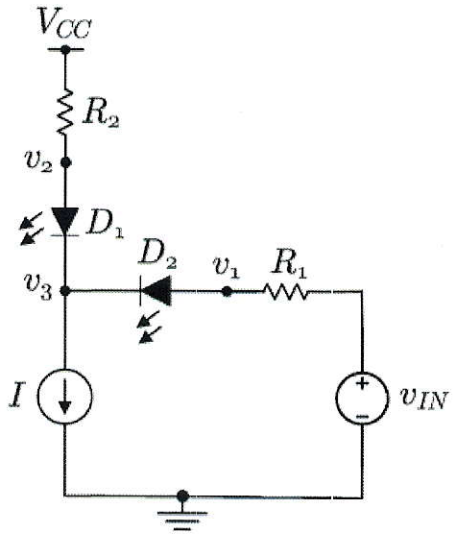

Fig. 1: Circuit of Q1.

1a) Determine the states of the two LEDs, i.e., *on* or *off*, if the input voltage v_{IN} is zero. Determine v_3 in this condition. Complete **Table 1a**. Show all the work.

Table 1a: Results of the diode circuit of Q1.

State of D_1	State of D_2	v_3 [V]
ON	OFF	3.5

1b) Repeat Part (1a) for $v_{IN} = 16.5\ V$. Complete **Table 1b**. Show all the work.

Table 1b: Results of the diode circuit of Q1.

State of D_1	State of D_2	v_3 $[V]$
OFF	ON	8

Q2: In the circuit of **Fig. 2**, $V_s = -15\ V$. If $V_O = -12\ V$ at a temperature of 20 °C, what will it be the 40 Celsius? At 0 Celsius? Explain why and/or show the calculations. Summarize your results in **Table 2**.

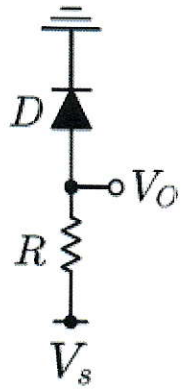

Fig. 2: Circuit of Q2.

Table 2: Results of the diode circuit of Q2.

T [°C]	20	40	0
$V_O[V]$	−12	−3	−14.25

Q3: In the rectifier of **Fig. 3**, the step-down center-tapped transformer has a voltage conversion ratio (i.e. the ratio v_S/v_I) of $120V/15V$. The source voltage v_S is a 60-Hz, 110-Vrms sinusoid. Each diode exhibits a relatively constant forward voltage drop of $1.0\ V$, and the smoothing capacitor is $1000\ \mu F$ in capacitance.

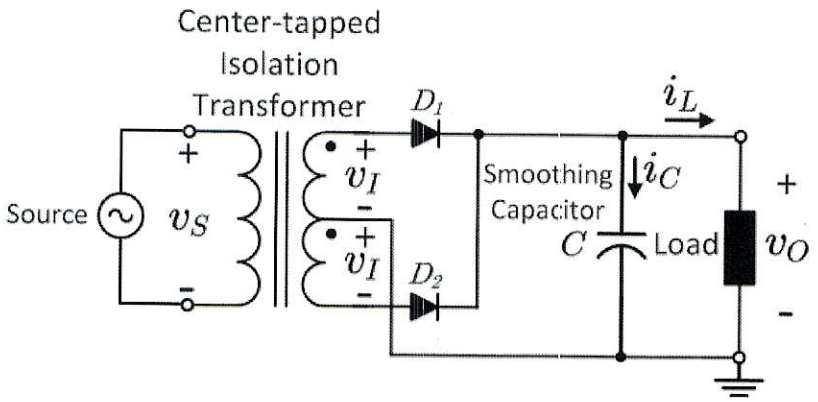

Fig. 3: Rectifier of Q3.

(3a) Determine the ***reading of a DC voltmeter*** of the output voltage v_O and the peak-to-peak ripple of v_O, if the load draws a constant current of 120 mA. Complete **Table 3a**. Show all the work.

Table 3a: results of the circuit of Q3.

DC meter reading of v_O $[V]$	Peak-to-peak ripple of v_O $[V]$
17.94	1.0

(3b) Repeat Part (3a) if the load is a **82 Ω** resistor. Complete **Table 3b**. Show all the work.

Table 3b: results of the circuit of Q3.

DC meter reading of v_o [V]	Peak-to-peak ripple of v_o [V]
17.50	1.88

(3c) Ignoring the output voltage ripple, determine the Peak Inverse Voltage (PIV) of each diode. Complete **Table 3c**. Show all the work.

Table 3c: results of the circuit of Q3.

PIV of each diode $[V]$
37.88

Q4: In the shunt voltage regulator of **Fig. 4**, $R = 820\ \Omega$. According to the manufacturer, the Zener diode gives a voltage of $v_Z = V_{ZT} = 5.1\ V$ at a test current of $i_Z = I_{ZT} = 20\ mA$. Further, $r_Z = 10\ \Omega$ and $I_{ZK} = 1.5\ mA$.

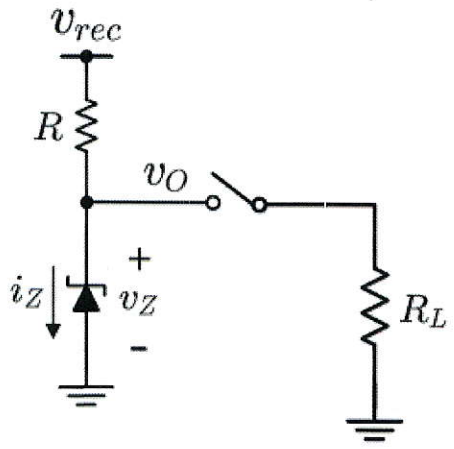

Fig. 4: Shunt regulator of Q4.

(4a) Assuming that the switch is open, determine the peak-to-peak ripple of the output voltage v_O if the (unregulated) voltage v_{rec} has a peak-to-peak ripple of 2.0 V. Complete **Table 4a**. Show all the work.

Table 4a: results of the circuit of Q4.

Peak-to-peak ripple of v_O $[V]$
0.024

(4b) Assuming that the switch is closed and $R_L = 1.0\ k\Omega$, calculate the minimum permissible value of v_{rec}. Complete **Table 4b**. Show all the work.

Table 4b: results of the circuit of Q4.

Minimum of v_{rec} $[V]$
10.18

(4c) Assuming that the switch is closed and $V_{CC} = 15\ V$, calculate the minimum permissible value of R_L. Complete **Table 4c**. Show all the work.

Table 4c: results of the circuit of Q4.

Minimum of R_L [Ω]
455

Q5: In the transistor circuit of **Fig. 5**, determine the mode of operation of the transistor and the node voltages. $V_{CC} = 10\ V$, $R_1 = R_2 = 1.0\ k\Omega$, $R_C = 100\ \Omega$, and $R_E = 220\ \Omega$. Assume that $V_{BEon} = 0.7\ V$, $V_{CEsat} = 0.3\ V$, and $\beta = 50$.

Complete **Table 5**. Show all the work.

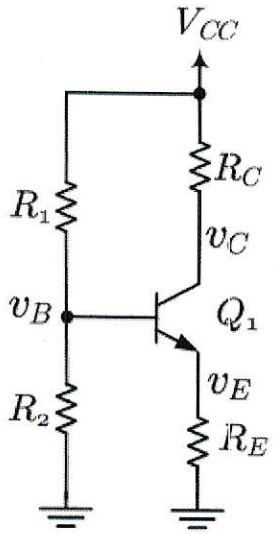

Fig. 5: Transistor circuit of Q5.

Table 5: transistor's mode of operation and the node voltages in the circuit of Q5.

Mode of Q1	$v_B[V]$	$v_C[V]$	$v_E[V]$
active	4.82	8.17	4.12