بسم الله الرحمن الرحيم

Ministry of Higher Education
King Fahd University of Petroleum & Minerals
Electrical Engineering Department

وزارة التعليم العالي
جامعة الملك فهد للبترول و المعادن
قسم الهندسة الكهربائية

EE 203: Electronics I

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Examination: First Major Exam

Date : October 6, 2013

Time: 5:45-7:15 PM

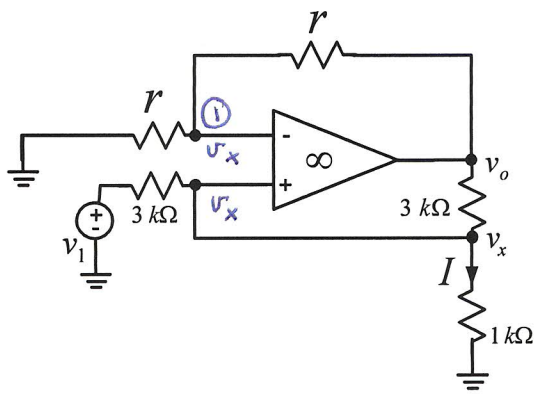
Student Name:	Key
Student Number:	
Section Number:	

Problem 1	
Problem 2	
Problem 3	
Total	

Answer All Questions

Problem (1-A) [points 7]

For the op amp circuit shown below, find the value of the current I in terms of v_1



KCL at ①

$$\frac{v_x}{r} + \frac{v_x - v_o}{r} = 0$$

$$v_o = 2v_x \quad \text{——} (1)$$

3 - marks

KCL at v_x

$$\frac{v_x - v_1}{3} + \frac{v_x - v_o}{3} + I = 0$$

3 - marks

$$2v_x - v_1 - v_o + 3I = 0 \quad \text{Sub. from (1)}$$

$$3I = v_1$$

$$\boxed{I = \frac{v_1}{3}}$$

1 - mark

Problem (1-B) [points 8]

Design the circuit shown in Fig. 1-b to have an input resistance of $100\ k\Omega$ and gain that can be varied from -1 V/V to -10 V/V using 10-$k\Omega$ potentiometer R_4 (R_4 can vary from 0 to $10\ k\Omega$). What voltage gain results when the potentiometer is set exactly at its middle value. (ideal op-amp)

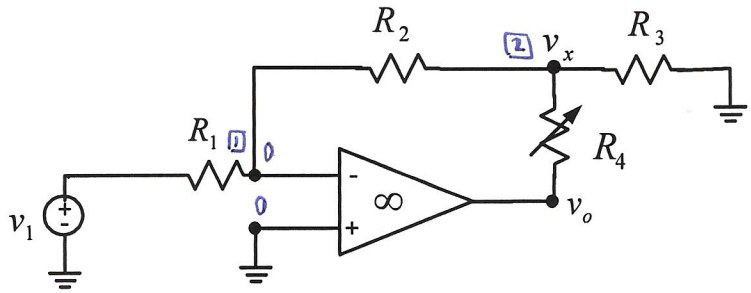


Fig. 1-b

Input resistance $= R_1 = 100\ k\Omega$ — 1 mark

KCL at 1

$$\frac{V_1}{R_1} + \frac{V_x}{R_2} = 0 \Rightarrow V_x = -\frac{R_2}{R_1} V_1 \quad \text{—(1)}$$ — 2 marks

KCL at 2

$$\frac{V_x}{R_2} + \frac{V_x - V_o}{R_4} + \frac{V_x}{R_3} = 0$$

$$V_o = \left[1 + \frac{R_4}{R_2} + \frac{R_4}{R_3}\right] V_x \quad \text{—(2)}$$ — 2 marks

From (1) into (2)

$$V_o = -\frac{R_2}{R_1}\left[1 + \frac{R_4}{R_2} + \frac{R_4}{R_3}\right] V_1$$

At $R_4 = 0$ $\quad V_o = -V_1 \Rightarrow R_1 = R_2 \Rightarrow R_2 = 100\ k\Omega$.

At $R_4 = 10\ k\Omega$ $\quad V_o = -\left[1 + \frac{10}{100} + \frac{10}{R_3}\right] V_1 = -10\ V_1$ — 2 marks

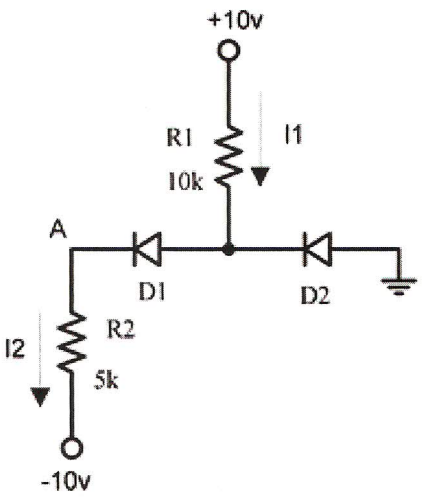
$$1.1 + \frac{10}{R_3} = 10 \Rightarrow \frac{10}{R_3} = 8.9 \Rightarrow R_3 = \frac{10}{8.9} = 1.1236\ k\Omega$$

Gain at $R_4 = 5\ k\Omega$

$$\frac{V_o}{V_1} = -\frac{100}{100}\left[1 + \frac{5}{100} + \frac{5}{1.1236}\right] = -5.5$$ — 1 mark

Problem (2-A) [5 points]

Analyze the diode circuit shown to determine the currents and voltage listed below, assuming constant voltage drop model diode with $V_{Do} = 0.7$ V **(show your analysis)**:



I_1 (mA)	1.07 (1½)
I_2 (mA)	1.72 (1½)
V_A (V)	−1.40 (2)

Assume both diodes are ON

$V_A = -1.4$ V

$I_1 = \frac{10 + 0.7}{10} = 1.07$ mA

$I_2 = \frac{-1.4 - (-10)}{5} = 1.72$ mA

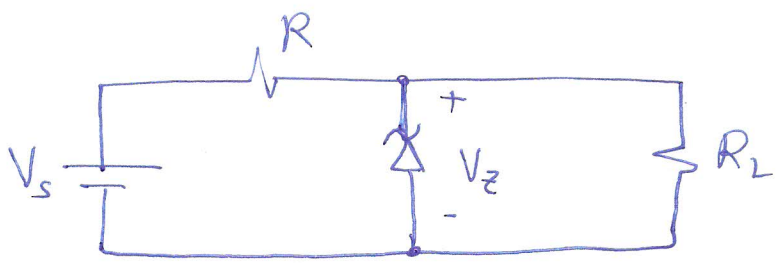
Problem (2-B) [5 points]

A shunt regulator utilizing a zener diode with an incremental resistance of 20 Ω is fed through a 480Ω resistor; the supply voltage varies by as much as 20% of its nominal values.

1. Find the line regulation.
2. Draw this regulator circuit including the load which can be represented by a resistor R_L.

1. $\frac{\Delta V_o}{\Delta V_s} = \frac{r_z}{r_z + R} = \frac{20}{20 + 480} = 0.04$ (2½)

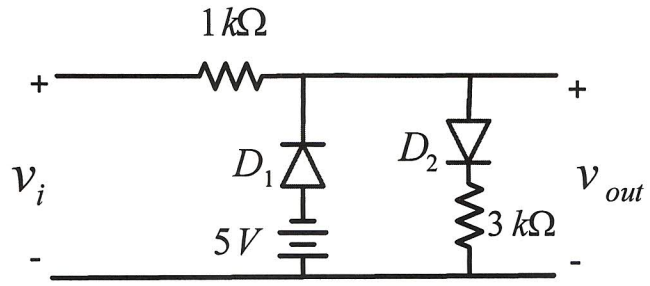
2.



(2½)

Problem (2-C) [5 points]

Sketch the transfer characteristics of the circuit shown assume ideal diodes,



If $V_i \leq -5$ V D_1 is ON , D_2 is off

marks (1)

$V_o = -5$ V .

If $-5 < V_i \leq 0$ D_1 and D_2 are off

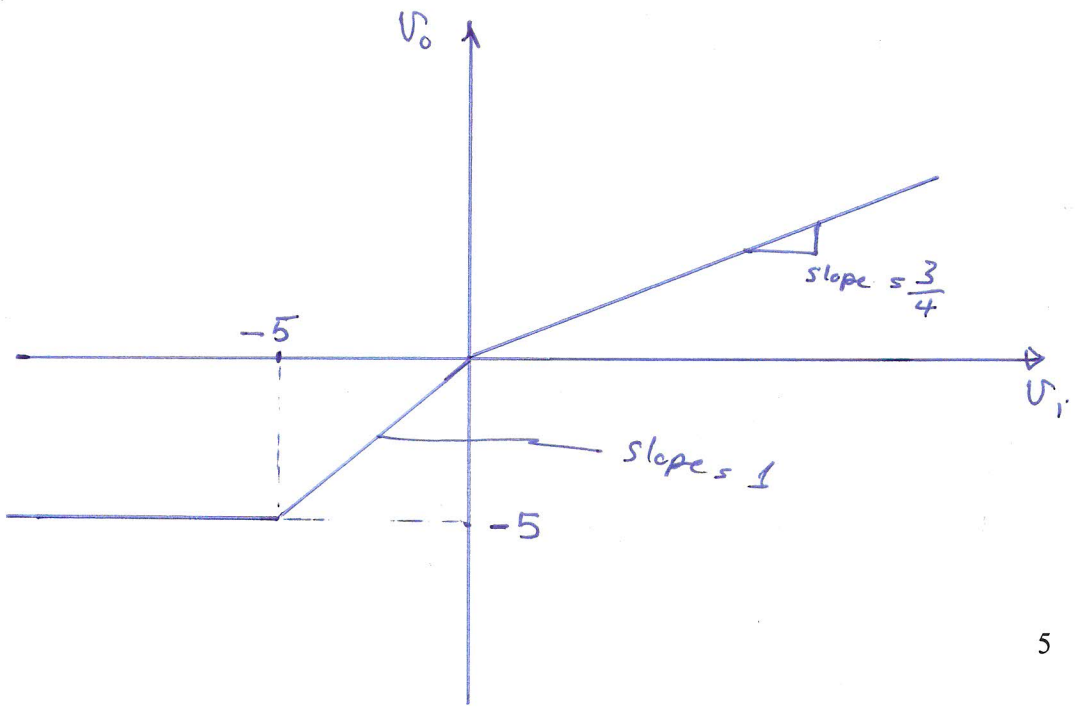
mark (1½)

$V_o = V_i$

If $V_i \geq 0$ D_1 off and D_2 is ON

$V_o = V_i \frac{3}{4}$

mark (2½)



Problem (3) [points 15]

The power supply circuit shown in Fig. 3.1 uses a full wave rectifier to obtain 18 V DC.

i- Sketch v_o before the capacitor is connected indicating the significant points.
ii- Find the ripple voltage.
iii- Find the value of the smoothing capacitor C.
iv- Find the value of the PIV across each diode.

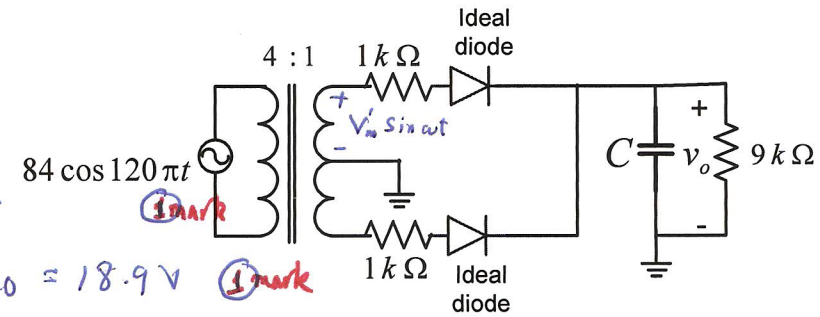
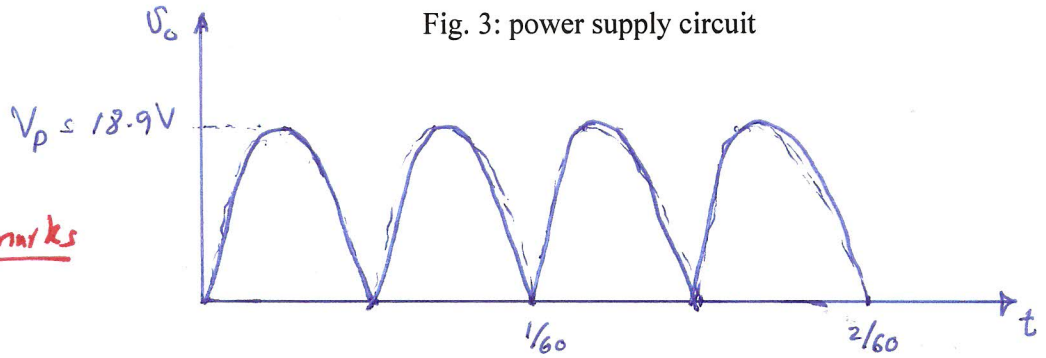


Fig. 3: power supply circuit

(i) $V'_m = \frac{84}{4} = 21$ V (1 mark)

$V_p = 21 \times 9/10 = 18.9$ V (1 mark)



3 marks

(ii) $V_r = \frac{V_p}{2f R_L C}$

$V_{DC} = V_p - \frac{1}{2} V_r$

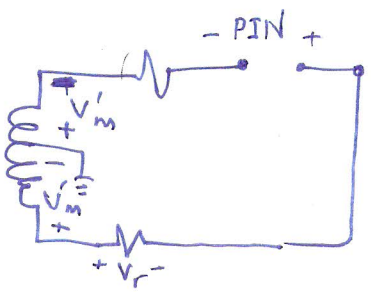
$18 = 18.9 - \frac{1}{2} V_r$ 4 marks

$V_r = 1.8$ V

(iii) $1.8 = \frac{18.9}{2 \times 60 \times 9 \times 10^3 \times C}$

$C = \frac{18.9}{120 \times 9 \times 1.8 \times 10^3} = 9.72$ MF. 3 marks

(iv)



3 marks

$PIV = 2V'_m - V_r$

$= 42 - (21 \times \frac{1}{10})$

$= 39.9$ V