Habib University

Electrical Engineering Department

Dhanani School of Science & Engineering

Course	EE/CE – 211 – Basic Electronics
Semester	Spring 2024
Section	Section L2
Exam	Midterm Exam – 1
Instructor	Dr. Ahmad Usman
Time allowed	1 hour and 30 minutes
Total Marks	25

Name: SOLUTION **Student ID:** _____

Note:

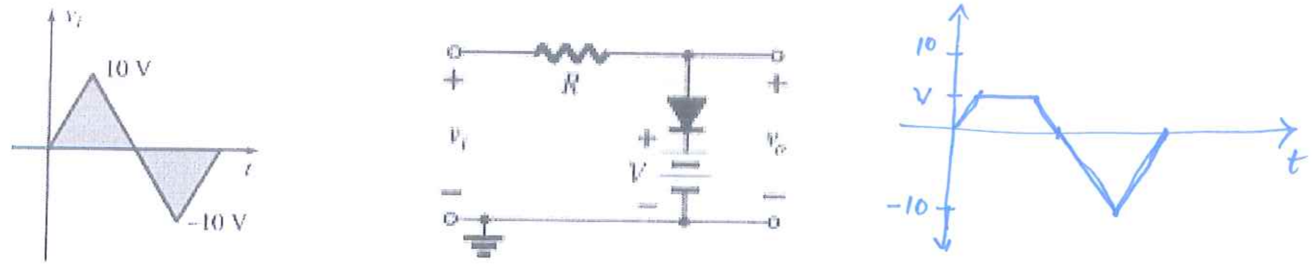
- Solve (provide answers) in the space provided after every question.
- You can use extra sheets for your answers. Attach them properly.
- Follow the instructions while solving the exam.

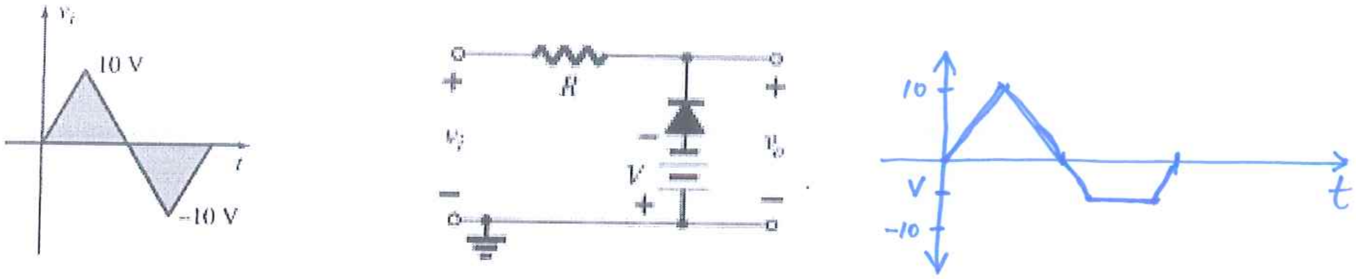
Course Learning Outcomes After the completion of the course the student should be able to		
CLOs	**Description**	**Learning-domain level**
CLO - 1	Explain and understand the working and behavior of semiconductor diodes, BJTs and MOSFETs in the modern electronic systems.	**Cog – 3**
CLO - 2	Ability to analyze DC and AC the behavior of the semiconductor diodes, BJTs, and MOSFETs in the modern electronic systems.	**Cog – 4**
CLO - 3	Develop an ability to design DC power supplies, DC biasing circuits and single stage amplifier circuits based on the concepts learned pertaining to semiconductor diodes, BJTs, and MOSFETs, for various modern electronic applications.	**Cog – 3**

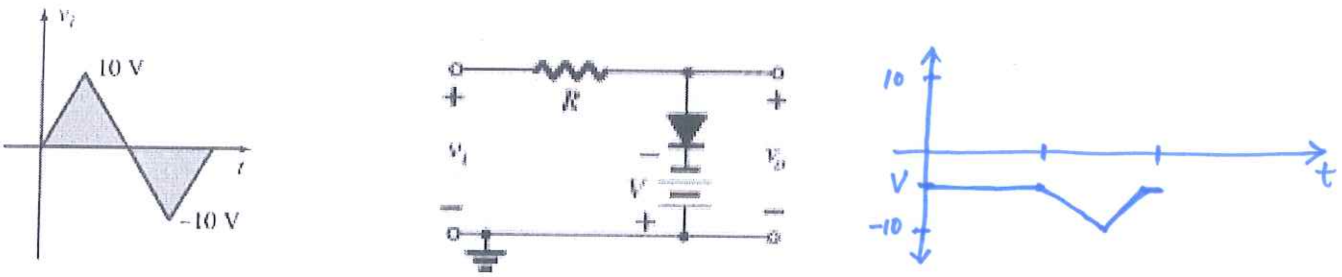
Question	**PLO**	**CLO - LDL**	**Points**
Question 1	1	1 – Cog – 3	**/10**
Question 2	1	2 – Cog – 4	**/05**
Question 3	2	3 – Cog – 3	**/10**
Total			**/25**

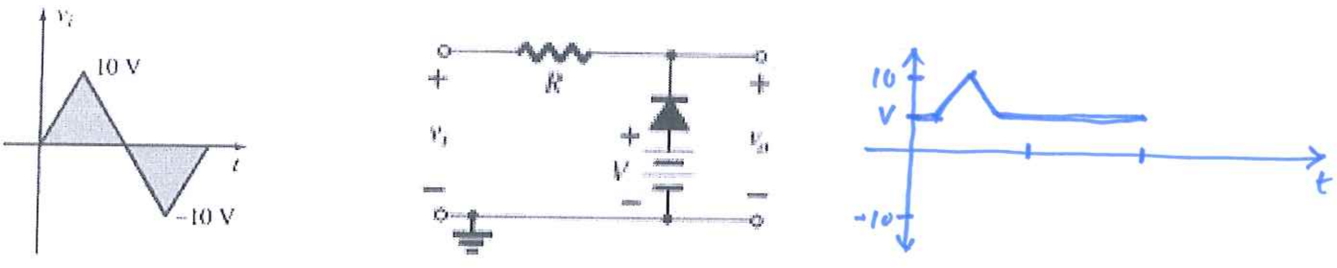
Question # 1 (CLO – 1 – Points: 10)

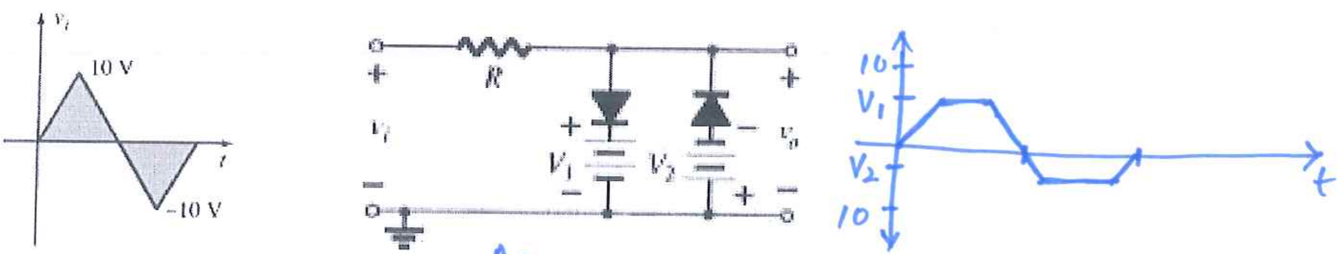
Determine Vo for the following circuits shown. Draw the output voltage waveforms for the circuits. Clearly label your waveform. Assume $V_{D,ON}$ = 0.7V. The input wave form is also provided.







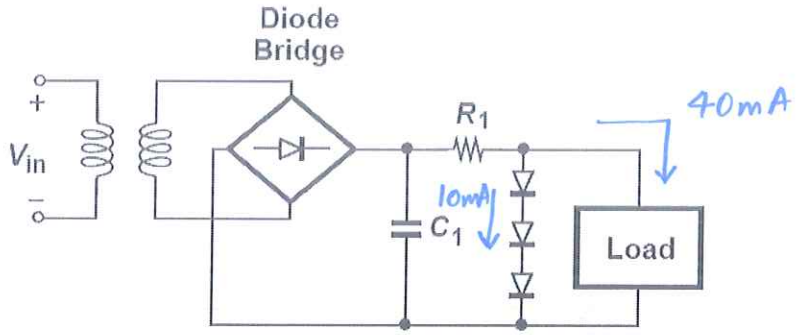




Assume
$(V_1 > V_2) < 10V$

Question # 2 (CLO – 2 – Points: 5)

In the figure shown below, the diodes are carrying a 10 mA current and the load draws 40 mA of current. If the load current increases by 2 mA, what is the change in the total voltage across the three diodes? Assume that the three diodes are similar diodes, having resistance of r_d. Assume R_1 to be greater that $3r_d$. Remember $r_d = V_T / I_D$.



Current through diodes = 10 mA

Load current = I_L = 40 mA

ΔI_L = 2 mA

$$r_d = \frac{V_T}{I_D}$$

where $V_T = 26\,mV$

$$r_d = \frac{26m}{10m} = 2.6\,\Omega$$

Total resistance of three diodes $= 3r_d = 3 \times 2.6$

$$r_d^T = 7.8\,\Omega$$

As, we know that

$V = IR$

$(\Delta V) = R(\Delta I)$ where $R = r_d^T$

$\Delta V = (7.8)(2m)$

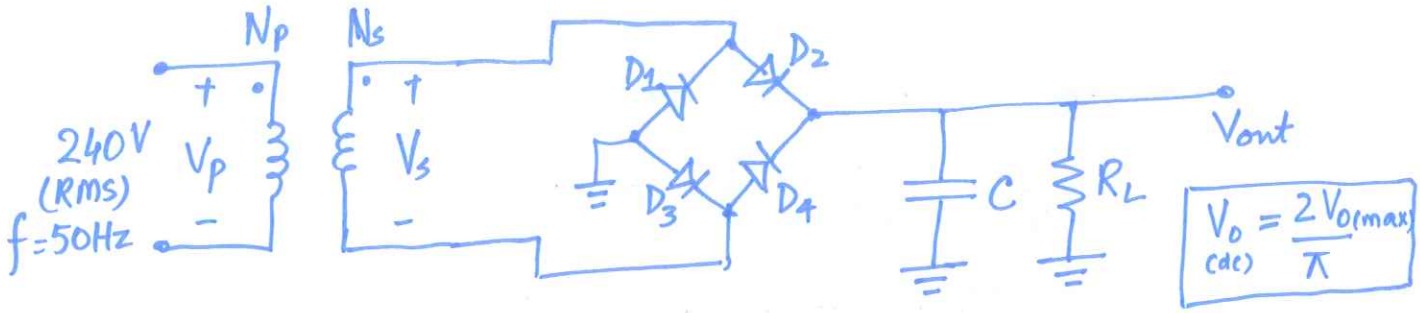
$\Delta V = 15.6\,mV$ ANS.

Question # 3 (CLO – 3 - Points: 10, 2 + 3 + 3 + 2)

Design a dc power supply using a bridge-rectifier to develop dc voltage across a load $R_L = 48\ \Omega$. The current through the load is 500 mA. Use a stepdown transformer whose primary side is connected to 240 V (RMS) at a mains frequency of 50 Hz. Assume practical silicon diodes ($V_{D,ON} = 0.7V$), safety factor (or safety multiplier) of 1.5. The allowed maximum ripple is ± 3%.

Note: You don't need to derive the formulas. Just use them for your calculations.

(a) Draw the circuit diagram.



(b) Calculate the rms voltage that appear across the secondary of the transformer, turn ratio of the transformer, and value of the filter capacitor.

$R_L = 48V$; $I_L = 500mA$

$V_{dc} = I_L R_L = 48 \times 500m = \boxed{24\ V}$

$V_{o(max)} = \frac{\pi}{2} V_{dc} = \boxed{37.704\ V}$

$V_{diode\ drop} = 2 \times 0.7V = 1.4V$

$V_s = V_{o(max)} + V_{diode\ drop} = 1.4 + 37.704$

$\boxed{V_s^{Rms} = 39.104\ V}$ Ans

$V_s^{Peak} = \sqrt{2}\ V_s^{Rms}$

$\boxed{V_s^{Peak} = 55.3014\ V}$

Turn Ratio:

$$\frac{N_P}{N_S} = \frac{V_P}{V_S} = \frac{240\ V_{RMS}}{39.104\ V_{RMS}}$$

$$\boxed{\frac{N_P}{N_S} = 6.1374} \quad \text{Ans}$$

Filter Capacitor

V_R // $\pm$ 3% of V_{dc}

V_R = 3% of 48 = 1.44 V_{dc}

$$V_R = \frac{I_L}{2C f_{in}}$$

$$C = \frac{I_L}{2V_R f_{in}}$$

$$C = \frac{0.5}{2(1.44)(50)}$$

$$\boxed{C = 3.472\ mF} \quad \text{Ans}$$

(c) Specify the PIV-rating, $I_{d,max}$ rating of the diodes, and power rating of the diodes.

PIV Rating:

Peak Inverse Voltage across the diodes $= 1.5 \times V_s^{Peak} = 1.5 \times 55.3014$

$= \boxed{82.9521\ V}$ Ans

$I_{d,max}$ Rating:

$I'_{Peak} = \frac{V_{Peak}}{R_L} = 1.1521\ A$

Rating $= 1.5 \times 1.1521 = \boxed{1.72816\ A}$ Ans

Power Rating:

$P^{dc}_{d(max)} = I^{dc}_{diode\ (max)} \times V^{dc}_{diode}$

$= \left(\frac{\pi}{2} I_{dc}\right) \times 0.7 = 785.5m \times 0.7 = \boxed{549.85\ mW}$ Ans

(d) Draw properly labeled input and output voltage waveforms of the designed dc power supply.

$V_{Peak} = V_{Rms}\sqrt{2}$