

KATHMANDU UNIVERSITY  
End Semester Examination  
July/August, 2024

Marks Scored:

Level : B.E.

Year : III

Exam Roll No. :

Registration No.:

Time: 30 mins.

Course : EPEG 318

Semester : II

F. M. : 10

Date : 26 JUL 2024

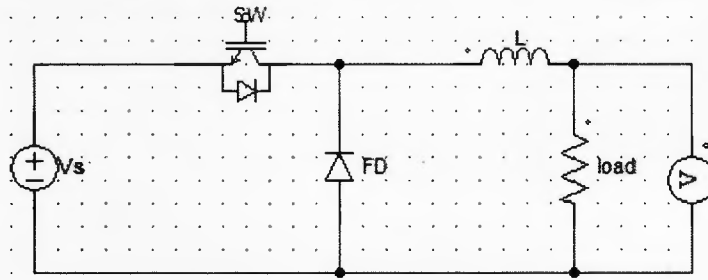
SECTION "A"

[20 Q.  $\times$  0.5 = 10 marks]

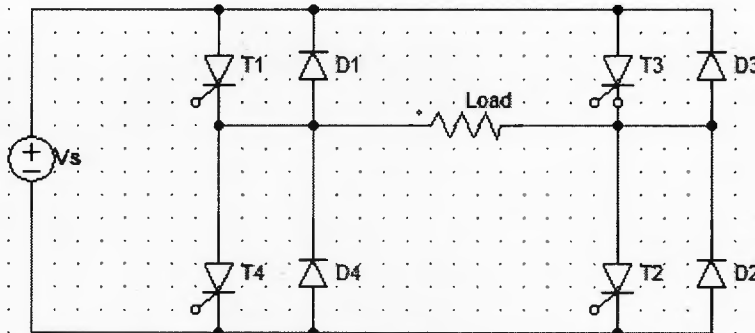
**Choose and encircle in the most appropriate option from each set of choices**

1. In AC voltage controllers the
  - a. Variable ac with fixed frequency is obtained.
  - b. Variable frequency with variable frequency is obtained.
  - c. Variable ac with fixed frequency is obtained.
  - d. Variable frequency with variable frequency is obtained.
  
2. In the principle of phase control
  - a. The load is on for some cycles and off for some cycles.
  - b. Control is achieved by adjusting the firing angle of the semiconductor devices.
  - c. Control is achieved by adjusting the number of on off cycles.
  - d. Control cannot be achieved.
  
3. A single phase half wave voltage controller consists of
  - a. One SCR in parallel with one diode.
  - b. One SCR in anti parallel with one diode.
  - c. Two SCR in parallel.
  - d. Two SCR in anti parallel.
  
4. In the integral cycle control of ac voltage controller, if the load is on for "n" cycles and off for "m" cycles, then the periodicity for a sinusoidal output is
  - a.  $m/2\pi(m+n)$
  - b.  $n/2\pi(m+n)$
  - c.  $m/\pi(m+n)$
  - d.  $n/2\pi(m+n)$
  
5. A voltage source  $V_s = V_m \sin \omega t$  is connected in series with a resistance R and an SCR. At some firing angle delay of " $\alpha$ ", a positive gate pulse is applied to the SCR which turns on the SCR. Considering ideal conditions, at the instant " $\alpha$ " the voltage at the resistor terminals,  $V_o$ 
  - a. Falls to zero.
  - b. Falls to  $-V_m \sin \alpha$ .
  - c. Rises to  $V_m \sin \alpha$ .
  - d. Rises to  $V_m \sin \omega t$ .
  
6. For a single phase thyristor circuit with R load & firing angle  $\alpha$ , the conduction angle can be given by
  - a.  $\pi + \alpha$
  - b.  $2\pi + \alpha$
  - c.  $\pi - \alpha$
  - d.  $\alpha$
  
7. The function of a snubber circuit across SCR is to
  - a. Suppress  $dv/dt$ .
  - b. Increase  $dv/dt$ .
  - c. Decrease  $dv/dt$ .
  - d. Keep transient voltage at a constant value.

8. The circuit with IGBT implemented as a switch is

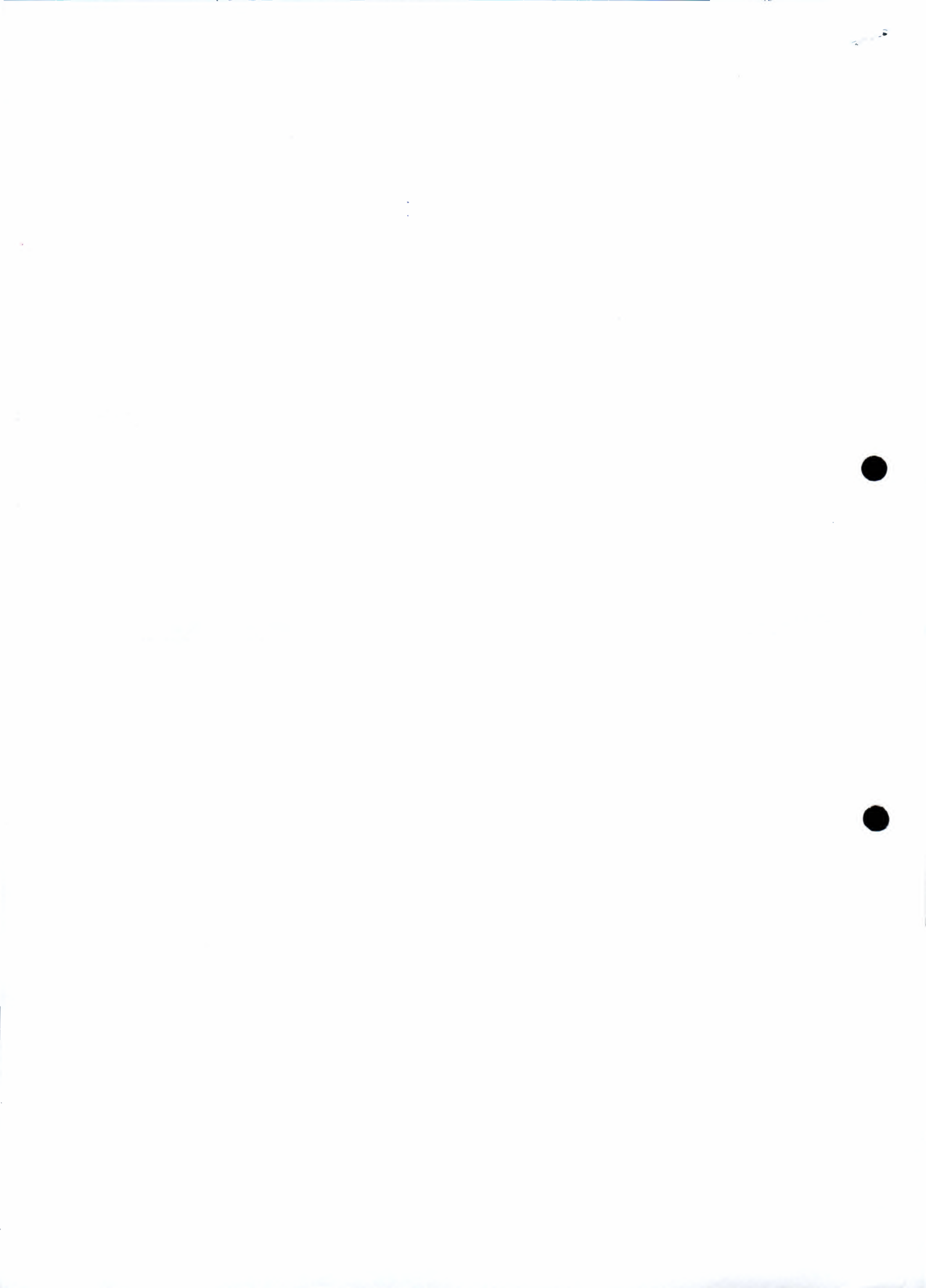


- a. Step up/step down chopper  
 b. Step down chopper.  
 c. Step up chopper  
 d. Ac voltage controller.
9. If a step up chopper is kept open, then ideally  
 a.  $V_o=0$   
 b.  $V_o=\infty$   
 c.  $V_o=V_s$   
 d.  $V_o>V_s$
10. The peak value of phase voltage in case of 3-phase VSI with  $180^\circ$  mode with the supply side consists of a constant dc voltage source of  $V_s$  is  
 a.  $V_s$   
 b.  $3V_s/2$   
 c.  $2V_s/3$   
 d.  $3V_s$
11. A single phase full bridge inverter has a dc voltage source  $V_s = 230$  V. Find the rms value of the fundamental component of output voltage  
 a. 90 Volts  
 b. 207 Volts  
 c. 350 Volts  
 d. 196 Volts
12. The diodes D1-D4 in circuit below is used to



- a. Reduce the switching losses.  
 b. send current back to the dc source when SCRs are off.  
 c. send current back to the load when SCRs are off  
 d. send current back to the dc source when SCRs are conducting
13. For a single-phase dual converter, with converters  $C_1$  and  $C_2$  connected in anti-parallel, which relation among the following is true to keep the average voltages from  $C_1$  and  $C_2$  equal?  $C_1$  and  $C_2$  have firing angles  $\alpha_1$  and  $\alpha_2$  respectively.  
 a.  $\alpha_1 = \alpha_2$ .  
 b.  $\alpha_1 + \alpha_2 = 180^\circ$ .  
 c.  $\alpha_1 + \alpha_2 = 360^\circ$ .  
 d.  $\alpha_1 + \alpha_2 = 90^\circ$ .
14. For a three phase full controlled converter, with 3 thyristors in the upper or positive group and 3 thyristors in the lower or negative group, at any given time  
 a. Two thyristors are conducting from each group.  
 b. One thyristor is conducting from each group.  
 c. One thyristor is conducting from either of the groups.  
 d. All 6 thyristors are conducting at a time.





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Semester : II  
F. M. : 40

SECTION "B"

[5 Q. × 8 = 40 marks]

Attempt *ANY FIVE* questions. Assume any suitable data if required.

1.

- a. Prove that for a step up/down converter, output voltage  $V_o = V_{in} * [K / (1-K)]$ ; where  $V_{in}$  is the input voltage to the converter and  $K = T_{ON} / T$  is the duty cycle of the converter. Plot the source voltage, source current, output voltage and output current waveforms considering RL load. [3]
- b. Describe the working principle of a single phase full wave diode rectifier supplying RL load showing output waveforms of source voltage, load current, output voltage and voltage across diode. Also, derive the expression for average value of output voltage. [3]
- c. A voltage source,  $V_s = 100 \sin 314t$  supplies a resistive load of  $10\Omega$  through a thyristor which performs half wave controlled rectification. Calculate the average power of the load for firing angle,  $\alpha = 45^\circ$ . [2]

2.

- a. A three phase ac switch with configuration as shown in figure 1 (a) below is used between a three phase 440V, 60 Hz supply and a three phase star, Y connected load. The load power is 10kW at a 0.85 lagging pf. Determine the [2]
  - i. line current, peak thyristor current
  - ii. average thyristor current, rms thyristor current

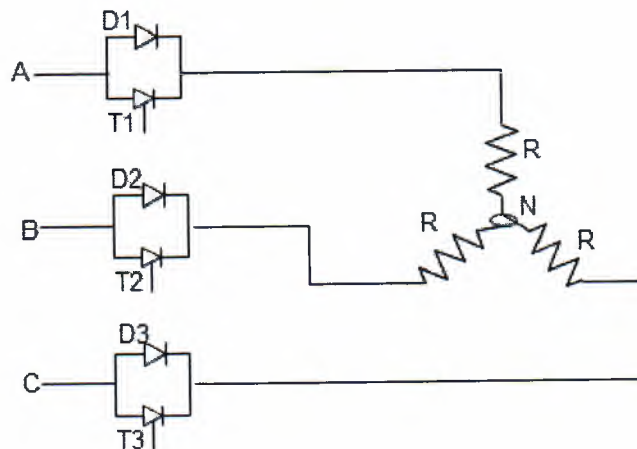


Figure 1 (a). Three phase ac thyristor switch

P.T.O.

- b. A single phase bridge type cyclo-converter feeds a load R. For an output frequency equal to one third of input frequency, sketch output voltage waveform for a firing angle of  $\alpha=30^\circ$ . Consider for only positive cycle of output voltage. [3]
- c. A single phase half bridge inverter, fed from 24V dc is connected to load,  $R=1.2 \Omega$ . Determine: [3]
- R.m.s output voltage at the fundamental frequency  $V_{o1}$ .
  - Total harmonic distortion.
  - Distortion factor considering upto 9<sup>th</sup> harmonics.

3.

- a. "The maximum phase voltage,  $V_{an}$  for a three phase  $180^\circ$  mode bridge voltage source inverter is  $2V_s/3$ , where  $V_s$  is the supply input dc voltage". Prove the statement with an illustration of waveform for only one phase voltage,  $V_{an}$  for conduction period of 0 to  $\pi$  only. [3]
- b. A single phase full wave controlled rectifier is connected to a 220V source. Calculate the firing angle necessary to deliver 500W power to a  $25\Omega$  load. [2]
- c. A 3-phase full-converter is connected to a resistive load. Show that the average output voltage ( $V_o$ ) is given, in terms of maximum line voltage ( $V_{ml}$ ) and SCR firing angle ( $\alpha$ ), as  $V_o = \frac{3V_{ml}}{\pi} \cos\alpha$  for  $0 < \alpha < \frac{\pi}{3}$  [3]

4.

- a. A step up chopper has an input voltage of 230V and output voltage of 650 Volts. If the non-conducting time of the thyristor chopper is 100  $\mu s$ , compute the pulse width of the output voltage. In case the pulse width is halved for constant frequency operation, find the new output voltage. [1.5+1.5=3]
- b. A three phase inverter has a star connected load of  $R= 5\Omega$  and  $L= 23mH$ . The inverter frequency is  $f_o = 60$  Hz and the dc input voltage is 220V. [1+1+1+1+1=5]
- Express the instantaneous line to line voltage  $V_{ab}(t)$  in a Fourier series.
  - Express the instantaneous line current  $V_{ab}(t)$  in a Fourier series
  - Total harmonic distortion.
  - Distortion factor.
  - Load power.

5.

- a. Plot the load voltage, load current and source current waveforms with reference to source voltage considering discontinuous load current for a single phase full converter feeding RL load. Assume the firing angle to be  $15^\circ$  and extinction angle to be  $190^\circ$ . [3]
- b. Mention various commutation techniques for a thyristor. Explain Class A type of commutation technique. [3]
- c. A three phase full converter delivers a ripple free load current of 10A with a firing angle delay of  $45^\circ$ . The input voltage is three phase, 400V, 50 Hz. Express current in Fourier series for upto 5<sup>th</sup> odd harmonics. [2]

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6.

- a. A diode circuit as shown in Figure 2 below with capacitor having an initial voltage;  $V_C(t=0) = -V_0 = 110\text{V}$ , capacitance,  $C = 10\ \mu\text{F}$ ; and inductance,  $L = 20\ \mu\text{H}$ . If switch  $S$  is closed at  $t = 0$ , determine (i) peak current through the diode (ii) conduction time of diode, and (iii) final steady state capacitor voltage. [1+1+1=3]

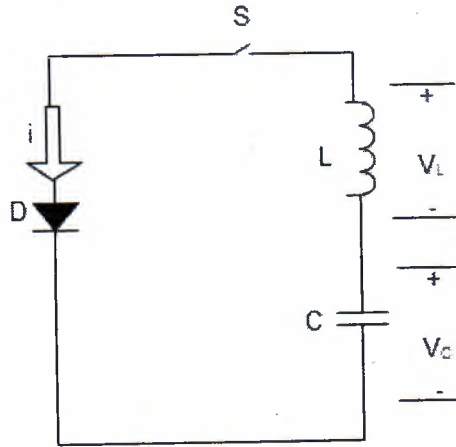


Figure 2. Diode circuit with LC load

- b. Describe the gate triggering method of turning on of a thyristor showing I-V characteristics [5]

