KATHMANDU UNIVERSITY
End Semester Examination [C]
November/December, 2023

07 DEC 2023

Level : B.E.
Year : III
Time : 2 hrs. 30 mins.

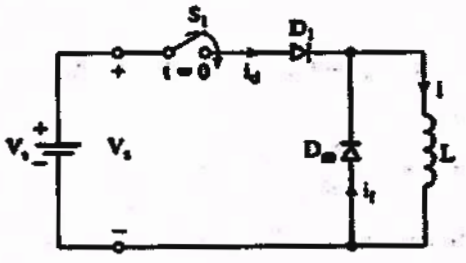
Course : EPEG 318
Semester : II
F. M. : 40

SECTION "B"
[4 Q.× 10 = 40 marks]

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

1.

a. In the figure below, if the resistance is neglected and source voltage Vs= 230 volts DC with inductance L = 250 μH. A diode circuit shown in Figure has R=22Ω and C=10μF.
   i. Draw the approximate waveform for the load current if the switch is closed for a time t_1=100μs and is then opened. [1.5]
   ii. Determine the final energy stored in the load inductor. [1.5]

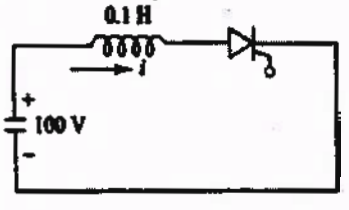


b. A single phase half wave rectifier is connected to a R load.
   i. Draw the circuit diagram, and derive the expression for average, rms value of output voltage, input power factor and efficiency. [2]
   ii. Plot the output waveforms for source voltage V_s, source current I_s, load voltage V_o, load current, and voltage across diode V_d. [2]

c. A three phase ac switch is used between a three phase 440V, 60 Hz supply and a three phase Y connected load. The load power is 20kW at a 0.707 lagging pf. Determine the voltage and current ratings of thyristors. [3]

2.

a. If the latching current in the thyristor circuit (which consists of L load of 0.1 H and dc source of 100 V) is 4 mA. Obtain the minimum width of the gating pulse required to properly turn on the thyristor. [3]



b. Explain the two transistor analogy of an SCR. [3]

c. Explain the turn on and turn off process of a thyristor with neat sketch of waveforms for anode current, anode voltage, gate voltage and gate current waveform on abscissa and time on ordinate. [4]

3.

a. Ten thyristors are used in string to with stand a dc voltage of 15 kV. Yhe maximum leakage current and recovery charge difference if thyristors are 10 mA and 150 μC, respectively. Each thyristor has a voltage sharing resistance of R = 56 kΩ and capacitance of C_1=0.5 μF. Determine, [1+1+1=3]
   i. maximum steady state voltage VDs (max)
   ii. steady state voltage derating factor.
   iii. maximum transient voltage sharing, VDT(max)

b. A half wave controlled rectifier supplied from 120V source is used to control the power to a 15Ω load. If the delay angle is 75^0, find [0.5+0.5+0.5+0.5=2]
   i. The power supplied to the load.
   ii. The maximum thyristor current.
   iii. The average thyristor current.
   iv. The thyristor maximum reverse voltage.

c. Single phase transformer with secondary voltage of 230V, 50 Hz delivers power to a load, R =10 Ohm through a half wave controller rectifier circuit. For a firing angle delay of 60 degree. Determine, [1+1+1+1+1=5]
   i. rectification efficiency,
   ii. form factor,
   iii. voltage ripple factor,
   iv. PIV of thyristor
   v. Transformer utilization factor.

4.

a. "A single phase full converter can also be employed as a line commutated inverter". Explain the inverter mode operation of single phase full converter with circuit diagram and waveform of source voltage, load voltage and load current. [3]

b. Explain the working principle of a three phase half wave converter or three phase three pulse converter with R load. Obtain the expression for average and rms value of output voltage and plot the waveforms of source voltage (phase), and load voltage. Consider firing angle for , [4]
   i. Continuous conduction mode, $\alpha < 30^0$,
   ii. Discontinuous conduction mode, $\alpha > 30^0$.

c. Explain the working principle of a single phase half bridge inverter considering resistive load. Derive the expression for instantaneous output voltage. [3]

5.

a. "The phase voltage outputs for 180^o mode three phase voltage source inverter have six steps per cycle". Justify the statement with circuit diagram, conduction table and phase output voltages for one cycle only. [4]

b. Explain the operating principle of a single phase step down center tapped/midpoint cycloconverter with R load reducing the output frequency (fo) to one third of supply frequency (fs) i.e. fo = 1/3 * fs. [3]

c. Mention various commutation techniques for a thyristor. Explain Class F type of commutation technique. [3]

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Exam Roll No. :

Time: 30 mins.

F. M. : 10

Registration No.:

Date : 07 DEC 2023

SECTION "A"
[20 Q. × 0.5 = 10 marks]

Choose and encircle the most appropriate option.

1. For the V-I characteristics of an SCR, which of the following statements are correct?
   A. It will trigger when the applied voltage is more than the forward breakover voltage.
   B. Holding current is greater than the latching current.
   C. When reverse biased, a small magnitude of leakage current will flow.
   D. It can be triggered without gate current.
   a. A, B and C. b. A, C and D. c. A, B and D. d. B, C and D.

2. In a 3 phase semi-converter, firing angle = 120^0 and extinction angle = 110^0. Each SCR and freewheeling diode conducts respectively for
   a. 60 degree, 50 degree. b. 30 degree, 50 degree.
   c. 60 degree, 10 degree. d. 30 degree, 40 degree.

3. In which type of the following choppers, do the voltage and current remains negative?
   a. Type A. b. Type E. c. Type C. d. Type D.

4. A single phase semiconverter or delayed full wave rectified sinusoidal current has an average value equal to one-third its maximum value. The delay angle is
   a. $Cos^{-1}0.047$. b. $Cos^{-1}0.866$. c. $Cos^{-1}0.678$. d. $Cos^{-1}0.386$.

5. AC voltage controller converts
   a. Fixed AC to fixed DC. b. Variable AC to variable DC.
   c. Fixed AC to variable AC. d. Variable AC to fixed AC.

6. In AC voltage controllers, the
   a. Variable AC with fixed frequency is obtained.
   b. Variable AC with variable frequency is obtained.
   c. Variable DC with fixed frequency is obtained.
   d. Variable DC with variable frequency is obtained.

7. In the principal 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 devices.
   c. Control is achieved by adjusting the number of on off cycles.
   d. Control cannot be achieved.

8. In the voltage controller circuit of figure 1,

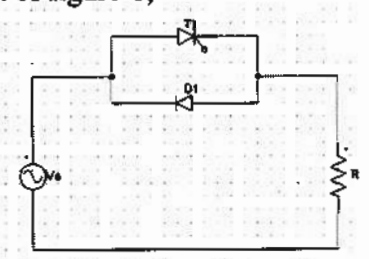

Figure 1. Voltage controller circuit for question 8.

a. The positive half cycle at the load is same as the supply voltage.
b. The negative half cycle at the load is same as the supply voltage.
c. The positive and negative half cycles at the load are identical to the supply.
d. The load voltage is zero.

9. The output voltage waveform in figure 2 below can be obtained by a

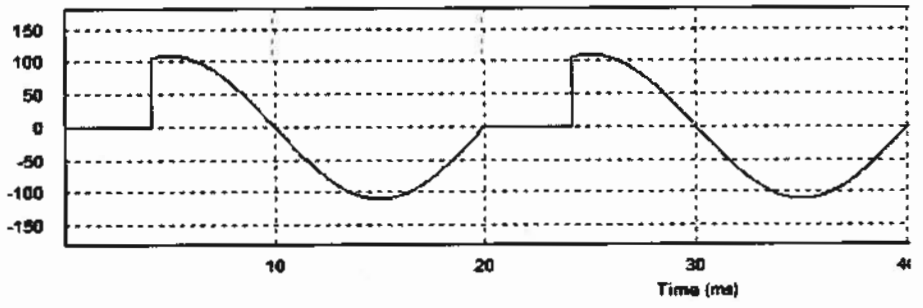

Figure 2. Output voltage waveform for question 9

a. Half wave ac voltage controller.
b. Full wave ac voltage controller.
c. Half wave controller with firing angle zero for single thyristor only.
d. Half wave controller with firing angle zero for both thyristors.

10. The circuit shown below in figure 3 is that of a

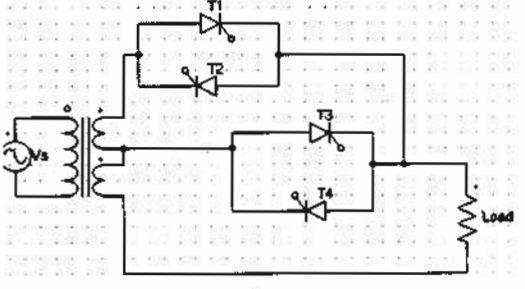

Figure 3. Controller circuit for question 10.

a. Four stage sequence controller.
b. Two stage sequence controller.
c. Full wave ac voltage controller.
d. Half wave ac voltage controller.

11. In a cycloconverter circuit as shown in figure 4, _____ and _____conduct in one cycle conduct together

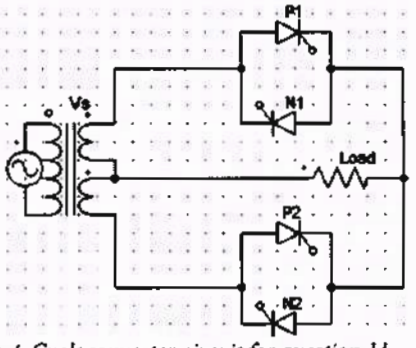

Figure 4. Cycloconverter circuit for question 11

a. P1, P2 and N1, N2
b. P1, N2 and N1, P2
c. N1, P1 and N1, P2
d. P1, N1 and P2, N2

12. In three phase cycloconverters the reduction factor is
a. input frequency/output frequency
b. (input frequency/output frequency) $^{-1}$
c. (input frequency/output frequency) $^{-1/2}$
d. (input frequency/output frequency) $^{1/2}$

13. In a thyristor gating circuit, the supply to the pulse amplifier is provided by the
a. Zero crossing detector.
b. Synchronizing transformer.
c. Isolation transformer.
d. Control signal generator.

14. In case of a cosine firing scheme, _____ is used to get a cosine wave
a. IC 555 timer
b. A comparator
c. An integrator circuit
d. A differentiator circuit

15. The thyristor turn off requires that the anode current
a. Falls below the holding current
b. Rises above the holding current
c. Falls below the latching current
d. Rises above the latching current

16. In case of class A type commutation or load commutation with low value of R load the
a. L is connected across R
b. L-C is connected across R
b. L is connected is series with R
d. L-C is connected in series with R

17. In a three phase half wave rectifier usually, the primary side of the transformer is delta connected because
a. it has no neutral connection.
b. we can get greater output voltage.
c. it provides a path for the triplen harmonics.
d. it provides better temperature stability.

18. The diode rectifier circuit in figure 5 is that of a

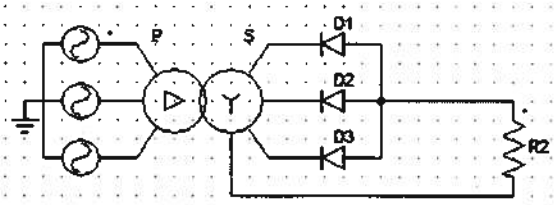

Figure 5. Diode rectifier circuit for question 18

a. Three phase half wave common cathode arrangement.
b. Three phase half wave common anode arrangement.
c. Three phase full wave common cathode arrangement.
d. Three phase full wave common anode arrangement.

19. In figure 6 shown below a diode rectifier circuit, if the diodes D1, D2 and D3 are connected to phases R, Y and B respectively the diode D1 would conduct from

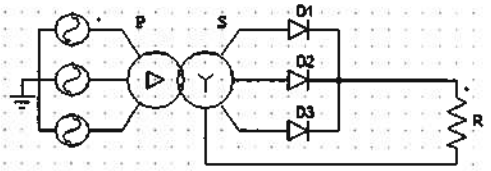

Figure 6. Diode rectifier circuit for question 19

a. 0 to 90 degree b. 30 to 150 degree c. 0 to 180 degree d. 30 to 180 degree

20. The average value of the output voltage, in a 3-phase half wave diode rectifier with Vml as the maximum line voltage value, is given by the expression

a. Vml/3π b. 3Vml/2π c. 3Vml d. 2 Vml/3 π