

JK LAKSHMIPAT UNIVERSITY, JAIPUR

INSTITUTE OF ENGINEERING AND TECHNOLOGY

End Term Examination (Backlog), November 2016

B. Tech in Electrical Engineering, Semester VI

Roll No.....

EE603: Industrial Electronics

Time: 3 hours

Max. Marks: 100

Instructions to students:

1. Do not write anything other than your roll number on question paper.
2. Assume suitable data wherever required and mention it clearly.
3. Writing appropriate units, nomenclature, and drawing neat sketches/schematics/ flow chart wherever, required are an integral part of the answer.

Q.1A Short answer/objective type questions (10 questions @ 1 mark) 10

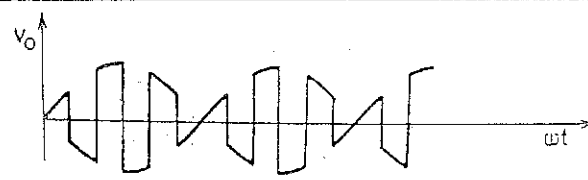
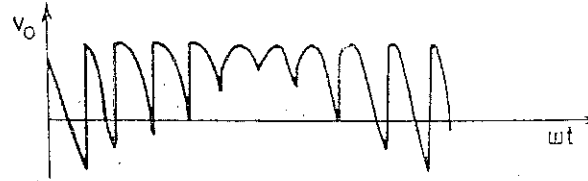
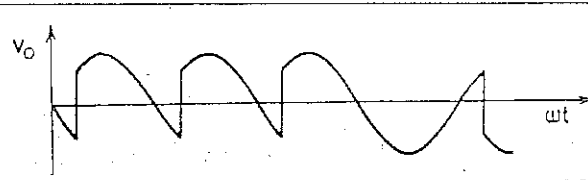
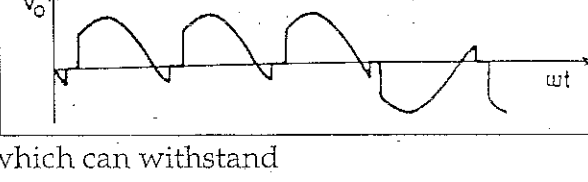
- i. Three-phase to three-phase cycloconverters employing 18 SCRs and 36 SCRs have the same voltage and current ratings for their component thyristors. The ratio of VA rating of 36-SCR device to that of 18-SCR device is
(a) 0.5 (b) 1 (c) 2 (d) 4
- ii. A 3-phase to 1-phase conversion device employs a 6-pulse bridge Cycloconverter. For an input voltage of 200 V per phase, the fundamental rms value of output voltage is
(a) $300/\pi$ (b) $300/\sqrt{3}$
(c) $600/\pi$ (d) $600/\sqrt{3}$
- iii. A load resistance of $10\ \Omega$ is fed through a 1-phase voltage controller from a voltage source of $200 \sin 314 t$. For a firing angle delay of 90° , the power delivered to load in kW, is
(a) 0.5 (b) 0.75 (c) 1 (d) 2
- iv. In a 1-phase voltage controller with RL load, ac output power can be controlled if
(a) $\alpha > \phi$ and $\gamma = \pi$ (b) $\alpha < \phi$ and $\gamma = \pi$
(c) $\alpha > \phi$ and $\gamma < \pi$ (d) $\alpha < \phi$ and $\gamma > \pi$
- v. In 1-phase modulation of PWM inverters, 3rd harmonic can be eliminated if pulse width is equal to
(a) 30° (b) 60° (c) 120° (d) 180°
- vi. In a inverter with fundamental output frequency of 50 Hz, if 3rd harmonic is eliminated, then frequencies of other components in the output voltage wave, in Hz, would be
(a) 250, 350, 450, higher frequencies (b) 50, 250, 350, 450
(c) 50, 250, 350, 550 (d) 50, 100, 200, 250
- vii. For a chopper, V_s is the source voltage, R is the load resistance and α is the duty cycle. RMS and average values of thyristor currents for this chopper are
(a) $\alpha \cdot \frac{V_s}{R}, \sqrt{\alpha} \cdot \frac{V_s}{R}$ (b) $\sqrt{\alpha} \cdot \frac{V_s}{R}, \sqrt{\alpha} \cdot \frac{V_s}{R}$
(c) $\sqrt{\alpha} \cdot \frac{V_s}{R}, \alpha \cdot \frac{V_s}{R}$ (d) $\sqrt{1-\alpha} \cdot \frac{V_s}{R}, (1-\alpha) \cdot \frac{V_s}{R}$

- viii. When a series LC circuit is connected to a dc supply of V volts through a thyristor, then the peak current through thyristor is
 (a) $V \cdot \sqrt{LC}$ (b) $V/\sqrt{LC}$
 (c) $V \cdot \sqrt{C/L}$ (d) $V \cdot \sqrt{L/C}$
- ix. In a 3-phase semiconverter, for a firing angle equal to 90° and for continuous conduction, each SCR and diode conduct, respectively, for
 (a) $30^\circ, 60^\circ$ (b) $60^\circ, 30^\circ$ (c) $60^\circ, 60^\circ$ (d) $30^\circ, 30^\circ$
- x. In a 1-phase full converter, the number of SCRs conducting during overlap is
 (a) 1 (b) 2 (c) 4 (d) 6

Q.2 Short answer type questions (4 questions @ 2.5 marks)

10

- i. Match the 'Type of Cycloconverter' with correct 'Output voltage waveform' as given in below table:

Type of Cycloconverter		Output voltage waveform	
A	1-phase to 1-phase with continuous conduction	P	
B	1-phase to 1-phase with discontinuous conduction	Q	
C	Step-up device	R	
D	3-phase to 1-phase device	S	

- ii. List the semiconductor devices which can withstand
 (i) Unipolar voltages and
 (ii) Bipolar voltages.
- iii. Discuss the following terms for diodes:
 Softness factor, PIV.
- iv.

Q.3A What is a converter? Illustrate your answer with examples.

3+2

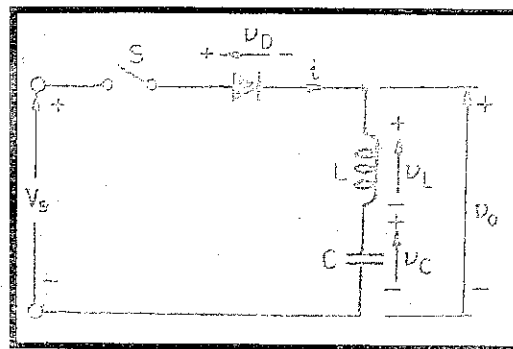
Q.3B Enumerate the types of power transistors along with their circuit symbols.

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Q.4A Discuss the two transistor model of thyristor. Using this model, describe various mechanisms of turning-off a thyristor.

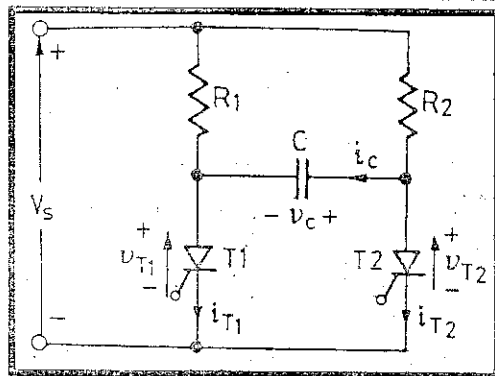
3+2

- Q.4B For the circuit shown in figure below, the circuit is initially relaxed. If switch S is closed at $t = 0$, sketch the variations of i , v_L , v_C and v_D as a function of time. Derive the expressions describing these functions.



3+2

Q.5A



For the circuit shown, employing class-C commutation, has $V_s = 200 \text{ V}$, $R_1 = 10 \Omega$ and $R_2 = 100 \Omega$. Determine

2.5

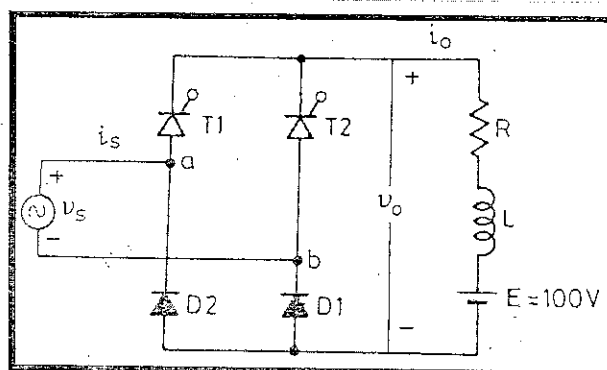
2.5

- (a) peak value of current through thyristor T1 and T2
(b) value of capacitor C if each thyristor has turn-off time of $40 \mu\text{s}$. Take a factor of safety 2.

- Q.5B A single-phase half-wave SCR feeds power to a resistive load. Draw waveforms for source voltage, load voltage, load current and voltage across the SCR for a given firing angle α . Hence obtain expressions for average and rms load voltages in terms of source voltage and firing angle.

3+2

- Q.6A A single-phase semiconverter, using two thyristors and two diodes as shown in figure, is supplied from 230 V , 50 Hz source. The load consists of $R = 10 \Omega$ and a large inductance so as to render the load current level. For a firing delay angle of 30° , determine
(a) average output voltage
(b) average output current
(c) average and rms values of thyristor currents.



1+2

+2

- Q.6B Discuss the main classification of dc to dc thyristor converters. Which of these is more commonly employed and why?

05

OR

- Q.6B A step-up chopper has input voltage of 220 V and output voltage of 660 V . If the non-conducting time of thyristor-chopper is $100 \mu\text{s}$, compute the pulse-width of output voltage.
In case pulse-width is halved for constant frequency operation, find the new output voltage.

3+2

Q.7A	Describe a voltage-commutated chopper with relevant current and voltage waveforms as a function of time. Enumerate the various simplifying assumptions made.	4+1
Q.7B	Write Fourier-series expression for the output voltages and currents obtained from single-phase half-bridge and full-bridge inverters.	05
OR		
Q.7B	A 1-phase bridge inverter is fed from 230 V dc. In the output voltage wave, only fundamental component of voltage is considered. Determine the rms current ratings of an SCR and a diode of the bridge for the following types of loads: (i) $R = 2\Omega$ (ii) $\omega L = 2\Omega$ Find also the repetitive peak voltage that may appear across a thyristor in parts (i) and (ii).	2+2 +1
Q.8A	Describe the two types of ac voltage controllers. Which one of these is preferred and why? A 1-phase voltage controller has input voltage of 230 V, 50 Hz and a load of $R = 15\Omega$. For 6 cycles on and 4 cycles off, determine (a) rms output voltage (b) input pf and (c) average and rms thyristor currents.	5+5
Q.9A	A 1-phase to 1-phase mid-point cycloconverter is delivering power to a resistive load. The supply transformer has turns ratio of 1:1:1. The frequency ratio is $f_0/f_s = 1/5$. The firing angle delay α for all the four SCRs are the same. Sketch the time variations of the following for $\alpha = 0^\circ$ and $\alpha = 30^\circ$: (a) Supply voltage (b) Output current (c) Supply current. Indicate the conduction of various thyristors also.	10
Q.9B	Write a short note on any two of the following: (i) Freewheeling diode and recovery of trapped energy (ii) Thyristor family members with symbols (iii) Class D commutation	5+5
OR		
Q.9B	Write a short note on any two of the following: (i) Four-quadrant chopper (ii) Three-phase bridge inverters (iii) Pulse width modulation	5+5