EXAMINATIONS – November 2013

Main

Duration	: 2H00
Max.Marks	: 70
Number of Questions	: 10
Number of pages	: 4

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Moderator	: Prof. Eugene Odendal

Instructions:

- Answer all questions
- No notes of any forms are allowed into the examinations
- Scientific calculators are allowed

PART A : Choose the correct answer **[1 x 5 =5 Marks]**

(1 Mark for the correct answer and -0.5 marks for the incorrect answer)

1. For a diode, reverse recovery time is defined as the time between the instant diode current becomes zero and the instant reverse recovery current decays to
   a. Zero
   b. b. 10% of reverse peak current I_{RM}
   c. 25% of reverse peak current I_{RM}
   d. 15% if of reverse peak current I_{RM}

2. A thyristorized, three phase fully controlled converter feeds a dc load that draws a constant current. Then the input ac line current of the converter has
   a. An rms value equal to the dc load current
   b. An average value equal to the dc load current
   c. A peak value equal to the dc load current
   d. A fundamental frequency component, whose rms value is equal to the dc load current

3. In PWM method of controlling the average output voltage in a chopper
   1. On-time T_{ON} is varied and chopping frequency f is kept constant
   2. T_{ON} is kept constant and f is varied
   3. Both T_{ON} and off-time T_{off} are varied and f is kept constant
   4. T_{off} is varied and T is kept constant

   From the above, the correct statements are
   a. 1,3
   b. 1,3,4
   c. 2,3,4
   d. 3,4

4. AC voltage controllers converts
   a. Fixed mains voltage to fixed ac voltage
   b. Fixed mains voltage directly to variable ac voltage without change in the frequency
   c. Fixed mains voltage directly to variable ac voltage with change in the frequency
   d. Fixed mains frequency to variable output frequency without change in voltage

5. A freewheeling diode is placed across the dc load
   1. To prevent reversal of load voltage
   2. To transfer the load current away from the source
   3. To transfer the load current away from the conducting thyristor

The correct statements are

a. 1,3
b. 2,3
c. 1,2
d. 1,2,3

PART B

Question 1: Line commutated converters **[15 Marks]**

A dc battery of constant emf E is being charged through a single phase half wave diode and a resistor circuit. For source voltage of 235V, 50Hz and for R= 8Ω , E = 150V

a. Determine the conduction angle at which the diode starts to conduct (1 Marks)
b. Derive the equation for average value of charging current (2 Marks)
c. Determine the value of average charging current (1 Marks)
d. Derive the equation for RMS value of charging current (2 Marks)
e. Determine the RMS value of charging current (1 Mark)
f. Find the power supplied to battery and power dissipated in resistor (2 Marks)
g. Calculate the supply power factor (2 Marks)
h. Find the charging time in case the battery capacity is 1000Wh and (1 Mark)
i. Find the rectifier efficiency and (2 Marks)
j. PIV of the diode (1 Mark)

Question 2: DC motor speed control circuits **[20 Marks]**

The speed of a separately excited motor is controlled by a three phase armature and single phase field converter circuits. ◦, The dc motor has an armature resistance of 0.5 ohm and field resistance of 100ohm, the motor voltage constant is 1.2 V/A rad/sec. Neglect the viscous friction and no load losses. The 3 phase M-3 armature converter circuit is operated from 3 phase, 230V, 50Hz supply and the armature current is kept constant at 20A. The single phase field circuit is operated from a single phase 230V, 50Hz supply with a delay angle of 45°. If an average output voltage of 50% of the maximum possible output voltage is required at the armature terminal, determine

a. Determine the maximum possible armature voltage value (2 Marks)
b. The delay angle of the armature circuit converter (7 Marks)
c. The speed in rpm (7 Marks)
d. Torque developed (2 Marks)
e. The total input power (2 Marks)

Question 3: DC – DC converters **[15 Marks]**

1. A class A chopper is used to drive a 220V, 50Hz, 1500 rpm motor from a 230V dc source. The chopping frequency is 600Hz. The field current is held constant to a value so as to give rated operation at 230V. The t_{ON} is set such that the longest harmonic content is obtained. Consider the rated armature current (I_a) is 67A, armature resistance (R_a) is 0.19Ω and armature inductance (L_a) is 2.95mH. Determine the speed of the motor (8 Marks)

2. A class A chopper is supplied from a battery of voltage 120V. The load voltage waveform consists of rectangular pulses of duration 2msec followed by OFF periods of 2.5msec. Determine
   a. The average value of output voltage (3 Marks)
   b. The RMS value of output voltage (2 Marks)
   c. The ripply factor (2 Marks)

Question 4: AC voltage controllers **[15 Marks]**

A single-phase half controlled ac regulator shown in fig.1 feeds power to a resistive load of 6Ω from a 230V, 50Hz supply. The firing angle of SCR is π/2.

d. Derive the equation for RMS value of output voltage (2 Marks)
e. Determine the RMS value of output voltage and output current (2 Marks)
f. Determine the input power factor (5 Marks)
g. Derive the equation for average value of output voltage (2 Marks)
h. Determine the average value of output voltage input current (2 Marks)
i. State the disadvantage of this type of ac regulator. (2 Marks)

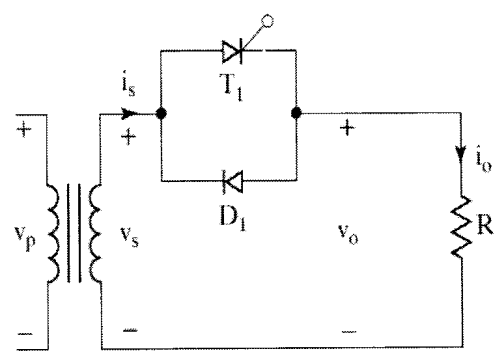

Fig.1 Single phase Half controlled ac regulator