EXAMINATIONS – November 2015

Main

Duration	: 2H00
Max.Marks	: 70
Number of Questions	: 14
Number of pages	: 6

Examiner	: Dr.Chitra Venugopal
Moderator	: Dr.Remy Tiako

Instructions:

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

PART A :

Choose the correct answer 1X10 = 10Marks

Note: 1 Marks for the correct answer and -0.5 mark for the incorrect answer

1. Power electronic equipment has very high efficiency, because
   a. The devices always operate in active region
   b. The devices never operate in active region
   c. The devices traverse active region at high speed and stay at the two states, on and off
   d. Cooling is very efficient

2. The softness factor for soft recovery and fast recovery diodes are respectively
   a. 1, greater than 1
   b. Less than 1, 1
   c. 1,1
   d. 1, less than 1

3. The function of sunbber circuit connected across an SCR is to
   a. Suppress dv/dt
   b. Increase dv/dt
   c. Decrease dv/dt
   d. Keep transient voltage at a constant value

4. In a thyristor
   a. Latching current I_L is associated with turn-off process and holding current I_H with turn-on process
   b. Both I_L and I_H are associated with turn-off process
   c. I_H is associated with turn-off process and I_L is associated with turn-on process
   d. Both I_L and I_H are associated with turn-on process

5. Commutation or turn-off of a thyristor requires that
   1. Anode current is reduced below holding current
   2. Anode voltage is reduced to zero
   3. Anode current is allowed to reverse
   4. Anode voltage gets reversed
   5. Reverse voltage is applied to it

   From these, correct statements are

   a. All
   b. 1,3,5
   c. 1,3,4,5
   d. 1,2,4

6. When a thyristor gets turned on, the gate drive
   a. Should not be removed as it will turn-off the SCR

b. May or maynot be removed
c. Should be removed
d. Should be removed to avoid increased losses and higher junction temperature

7. The selection of rectifier diode depends mostly on
   a. Forward voltage
   b. Reverse voltage
   c. Fault current
   d. Average load current

8. The disadvantage of half wave diode rectifier circuit is that the
   a. Diode must have high PIV rating
   b. Diode must have high power rating
   c. Output voltage is difficult to filter
   d. Diode must have high current rating

9. A freewheeling diode across inducting load will provide
   a. Quick turn-on
   b. Slow turn-off
   c. Reduced utilization factor
   d. Improved power factor

10. Two identical SCRs are connected back to back in series with a load. If each SCR is fired at 90°, a PMMC voltmeter across the load would read
    a. Peak voltage
    b. Peak voltage / π
    c. Zero
    d. Peak voltage / 2

PART B

I. Line Commutated Converters **(20 Marks)**

A full wave bridge circuit with RL load shown in fig.2a.

DATA: Line to Line voltage $V_L = 400V$

Average Road current $I_d = 100A$

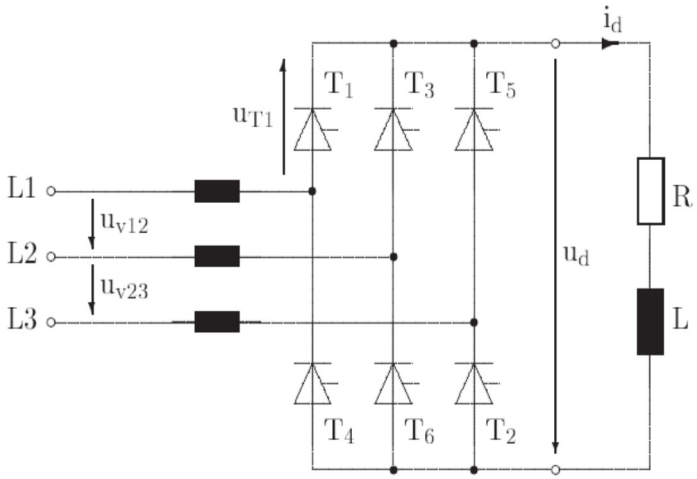

Fig.2a

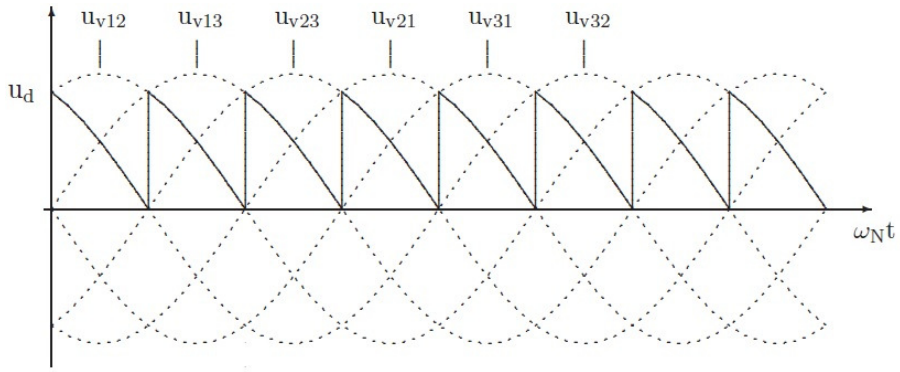

Fig.2b.

Questions

a. Calculate the maximum ideal DC voltage V_{d0} (3 Marks)

b. In fig. 2b, the grid of the line to line voltages U_{v12}, U_{v13}, …, U_{v32}, and the output voltage trajectory U_d is given for one operating point,

   a. Calculate the firing angle α (2 Marks)

   b. Calculate the ideal DC voltage corresponding to the firing angle calculated in step a. (3 Marks)

c. Does the load current become zero (2 Marks)

d. Highlight the times in which the six thyristors T_1 to T_6 are conducting for one line period (take care about the numbering of the line to line voltage) (6 Marks)

e. Draw the trajectory of the thyristor voltage U_{T1} for one line period (2 Marks)

f. Calculate the maximum reverse blocking voltage of the thyristor which can occur in this circuit. (2 Marks)

II. DC motor speed control circuits (20 Marks)

A separately excited dc motor is fed from a 230V, 50Hz supply via a single-phase, fully controlled rectifier. The motor parameters are

Armature Inductance (L_a)	:0.06H
Armature Resistance (R_a)	:0.3Ω
Motor voltage constant (K_a)	:0.9V/A rad/sec
Field resistance (R_f)	:52Ω
Load torque (T_L)	:50N-m at 800rpm.

The field current is controlled by a half-controlled rectifier connected to the same supply. The field voltage is set to the maximum possible value. The inductances of the armature and field circuits are sufficient enough to make the armature and field current continuous and ripple free.

Questions

Compute:

a. The field current I_f (4 Marks)
b. The armature current (2 Marks)
c. The armature voltage (4 Marks)
d. The firing angle of the converter in the armature circuit (2 Marks)
e. The input power from the supply neglecting the system losses (2 Marks)
f. The RMS value of the input current (2 Marks)
g. Input Volt-ampere rating of the converter (2 Marks)
h. Input power factor assuming neglible harmonics (2 Marks)

III. DC – DC converters (10 Marks)

In a toy car model designed to accelerate and decelerate at frequent intervals, a dc chopper circuit is used to control the power delivered to the motor. The dc input to the chopper circuit is 100V. The motor resistance and inductance is 10Ω and 50mH respectively. The inductance is large enough to maintain constant current at the motor terminals.

a. Show the chopper circuit suitable to perform the above mentioned operation (2 Marks)
b. While accelerating the armature voltage of the motor is increased to 150V at a constant frequency of 1kHz. Calculate

i. The required duty cycle (2 Marks)

ii. Average current at the motor terminals (2 Marks)

c. While decelerating, the motor requires 75V to maintain constant current at armature. Calculate

i. The required duty cycle (2 Marks)

ii. Maximum output current that can be available at the motor terminal. (2 Marks)

IV. AC voltage controllers (10 Marks)

In a heat control system, a resistive load of 10Ω is connected to a 110V AC supply via a single phase AC voltage controller circuit.

Questions

a. Draw a suitable AC voltage controller circuit that can connect and disconnect the load to the supply for 2 cycles and 4 cycles respectively. (2 Marks)

b. Draw the trajectory of the load voltage in integral cycle and phase control methods (2 Marks)

c. Calculate the power delivered to the load in integral cycle control method (2 Marks)

d. If phase control method is chosen, calculate the power delivered to the load at a firing angle of 30° (2 Marks)

e. Calculate the peak reverse voltage of thyristors. (2 Marks)