

B.E.7th SEMESTER (EE) FINAL EXAMINATION, 2011
Industrial Power Electronics (EE702)

Full Marks: 70

Time: 3hrs

- (i) Use separate answer script for each half
- (ii) The questions are of equal value
- (iii) Answer any **SIX** questions taking **THREE** from each half
- (iv) **Two marks** reserved for neatness in each half

FIRST HALF

1. The following data are specified for a 415 V, 2.2 kW, 1450 r.p.m. separately excited d.c. motor and its speed control system employing armature drop compensation:

Back emf constant = 0.27 V/r.p.m.

Armature circuit resistance = 2.2 Ω

Armature circuit inductance = 0.02 H

Total moment of inertia of motor and load = 2.1 kg-m²

Output resistance of controlled rectifier = 2 Ω

Filter choke inductance = 0.1 H

Firing circuit and controlled rectifier combination gain = 45

Summing amplifier gain = 1

- i) Calculate the gain factor of the current transducer so that the system has a damping ratio of 0.7.
- ii) Calculate the percent speed regulation and hence the no-load speed.
- iii) Calculate the reference input to the current comparison amplifier to limit the armature current to 130% of the full-load value.
- iv) Calculate the damping ratio of the system if the current feedback loop is opened.

[3+4+2+2]

2. a) Can you apply a forward voltage across a thyristor soon after the reverse recovery current drops to zero? Give reasons.
- b) What are the differences between converter grade thyristor and inverter grade thyristor?
- c) Explain the turn-on and turn-off processes of a GTO with the help of the two transistor analogy.
Discuss the merits and demerits of a GTO as compared to a conventional thyristor.

[3+2+6]

3. a) Explain the constructional details of a n-channel power MOSFET. What is the inversion layer? How is it formed?
- b) Discuss the switching characteristics of a power diode. What are the differences between p-n junction diodes and Schottky diodes?

[(3+1+2)+(3+2)]

4. a) Design a triggering circuit using UJT with the following parameters:

Inter-base voltage (V_{BB}) = 30 V

Intrinsic stand-off ratio η = 0.51

Valley-point current, I_v = 10 mA

Valley-point voltage, V_v = 3.5 V

Peak-point current, I_p = 10 μ A

Forward voltage drop of diode, V_D = 0.5 V

The frequency of oscillation is 60 Hz and width of triggering pulse is 50 μ s.

b) Explain the following ratings of an SCR and state their significances:

(i) V_{DRM} , (ii) V_{RSM}

c) The load torque of a separately excited d.c. motor is proportional to its shaft speed. Find the transfer function between the shaft speed and the armature voltage. Also find an expression for the damping ratio of the system. Under what condition can this transfer function be simplified to a lower order form? Write the lower order form. [3+2+6]

5. Write short notes on:

a) UPS

b) Equivalent circuit of an IGBT

c) Snubber circuit

[4+4+3]

SECOND HALF

6. Draw the waveforms of output voltage, voltage across and current through any one thyristor and any one line current of a 3-phase semi-converter for a firing angle of 45° and highly inductive load. What is the function of freewheel diode? Calculate the average value, rms value and ripple factor of the output voltage when the input is 3 phase 400V 50Hz ac.

[5+2+4]

7. (a) Prepare a brief comparison between integral cycle control and phase control strategies for an ac voltage controller. Mention their suitable applications.

(b) With necessary circuit diagram and waveforms, explain the operation of ac voltage controller when the output voltage is adjustable between V_1 and V_2 .

[(4+2)+5]

8. (a) Draw the circuit of a buck-boost converter and explain its operation with the help of necessary waveforms.

(b) Design a buck-boost converter having the following specifications:

Input voltage = 50 V

Output voltage = 100 V

Switching frequency = 30 kHz

Maximum allowable ripple in output voltage = 1% of rated value

Maximum power output = 500W

All other data if required should be assumed with justification.

[6+5]

9. (a) Develop ac output voltage using a single phase half bridge inverter operating from a two wire dc supply.

(b) What is the limit of conduction angle of each switching device of a 3 phase bridge inverter and why?

(c) Explain the operation of a 3 phase bridge inverter for minimum conduction angle. Draw the phase and line voltage patterns of output voltage for a star connected balanced load.

[4+1+6]

10. (a) Explain different methods for adjustment of output voltage of an inverter.

(b) Write short notes on SMPS.

[6+5]