B.E. (EE) Part-IV 7th Semester Final Examination, 2012

Industrial Power Electronics (EE-702)

Time : 3 hours **Full Marks : 70**

Use separate answer-script for each half.
Answer any **SIX** questions, taking **THREE** from each half.
Two marks are reserved for neatness in each half.

FIRST HALF

1. a) The latching current of a thyristor connected in between a d.c. voltage source of 200V and the load is 50 mA. The duration of the firing pulse is 50 μs. The load consists of a resistance of 20 Ω in series with an inductance of 0.5 H. Will the thyristor get fired? Give reasons.

   b) Explain the purpose of connecting i) a resistor across gate-cathode terminals ii) a diode in series with gate circuit and iii) a capacitor across gate-cathode terminals, of a thyristor.

   c) For a GTO, α_1=0.3, α_2=0.85 and I_A= 1A. Find the value of turn-off gain. The symbols have their usual meanings.

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

   (i) V_{DWM} (ii) V_{RSM}

   Indicate the locations of the above voltage ratings on a typical static i-v characteristic of a thyristor.

   [3+3+2+3]

2. a) 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.

   b) Following are the parameters and ratings of an UJT.

   Inter-base voltage (V_{BB}) = 12 V, Inter-base resistance (R_{BB}) = 5.6 kΩ

   Intrinsic stand-off ratio (η) = 0.63, Valley-point current (I_v) = 4 mA

   Valley-point voltage (V_v) = 2 V, Peak-point current (I_p) = 5 μA

   The maximum gate voltage (V_{GD}) that will not trigger the SCR = 0.18V

   Design a suitable UJT based trigger circuit for a single-phase converter (rectifier) operating from a 50 Hz ac mains supply. [(3+3)+5]

3. a) The specified limits for di/dt and dv/dt for an SCR are 60 A/μs and 300 V/μs respectively. The supply voltage is 240 V d.c. Determine the values of the snubber circuit parameters and the value of the inductor used to limit di/dt. Take the damping ratio as 0.7. Derive the various expressions used.

b) Explain the constructional details of an IGBT. Discuss its transfer and output characteristics.

[4+(4+3)]

4. 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 = 2.2 kg-m^2
Output resistance of controlled rectifier = 2.4 Ω
Filter choke inductance = 0.1 H
Firing circuit and controlled rectifier combination gain = 50
Current transducer gain = 75 mV/A
i) Calculate the gain of the summing amplifier to achieve critical damping.
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 125 % of the full-load value.
iv) Calculate the damping ratio of the system if the current feedback loop is opened. [3+4+2+2]

5. Write short notes on: [3+4+4]

a) Advantages of A.C. Drives

b) Transfer and Output characteristics of Power MOSFETs

c) Schottky diode

SECOND HALF

6. Explain the terms which are used as performance factors of a rectifier. Compare the performance factors of a single phase half-wave diode rectifier and a single phase full-wave diode bridge rectifier. [3+8]

7. (a) What do you mean by CCM and DCM operation of a converter? Derive the expression for current through an R-L-E load connected to the output of a 3-phase full controlled rectifier under continuous conduction mode of operation.

(b) Draw the circuit diagram of a single phase semi-converter and explain the operation of this converter. Mention the merits and demerits of semi converter over full converter.

[(1+5)+5]

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

(b) Design a buck converter having following specifications:

Input voltage = 100 V
Output voltage = 20 V
Switching frequency = 25 kHz
Maximum allowable ripple in output voltage = 1% of rated value
Maximum power output = 200W
Any other data, if required, should be assumed with proper justification.

[6+5]

9. (a) Explain the operation of a 3 phase bridge inverter for 180° conduction mode. Draw the phase and line voltage patterns of output voltage for a star connected balanced load and derive the expression for rms value of line voltage.

(b) Explain how output voltage of a single phase inverter can be adjusted by PWM technique.

[7+4]

10. (a) Prepare a brief write-up on flyback converter.

(b) Explain the operation of a single phase Auto-Sequentially Commutated (ASC) Current Source Inverter. [6+5]