* R M - 7 7 6 3 / 1 0 0 *

RM-7763

B. E. IV (Sem. VIII) (E) Examination

May / June – 2010

Advanced Power Electronics

(Elective)

Time : 3 Hours] [Total Marks : **100**

Instruction :

(1)

નીચે દર્શાવેલ ☛ નિશાનીવાળી વિગતો ઉત્તરવહી પર અવશ્ય લખવી.
Fillup strictly the details of ☛ signs on your answer book.

Name of the Examination :

☛ **B. E. 4 (Sem. 8) (ECC)**

Name of the Subject :

☛ **Advanced Power Electronics (Elective)**

☛ Subject Code No. : **7 7 6 3** ☛ Section No. (1, 2,.....) : **1&2**

Seat No. :

Student's Signature

(2) Attempt all questions.

(3) Answers to the **two** sections must be written in separate answer books.

(4) Any type of calculator can be used.

(5) Figures to the **right** indicate marks.

Section - I

Q.1 **Answer in one or two sentences. Each question carries one mark.** **(10)**

(a) What is the reason for using a 12-pulse converter for each of the poles in a HVDC system ?

(b) Draw a voltage sink type load.

(c) Mention the purpose(s) of using a transformer in a flyback type of SMPS.

(d) Why thyristor controlled inductors can not provide instantaneous VAR regulation ?

(e) Which converter is best suited for power factor pre-regulator purpose ?

(f) What do one mean by 'hold-up time' when referred to SMPS ?

(g) In which class can one categorize the forward converter: **(i)** with unidirectional excitation or **(ii)** with bi-directional excitation ?

(h) Mention the range of firing angle for which the thyristor controlled inductor can work as a variable inductor.

(i) State the factors on which the ripple in the output voltage of dc-dc converter depends.

(j) What is the range of controllable reactance if the reactance L is used in series with back to back connected SCRs in a given TCR ?

Q.2 **(a)** Compare linear voltage regulators with SMPS. **(3)**

(b) Draw the circuit of buck-boost converter. From the principle of duality show that Cuk converter is identical to Buck-boost converter. Obtain the equation for output voltage in terms of duty ratio for Cuk converter. Clearly state the advantages of latter over the former. **(7)**

OR

Q.2 **(a)** Explain the concept of 'current sink' and 'voltage sink' in relation to power factor correction. **(4)**

(b) A flyback SMPS supplies a load of 40 A at 5V. The source voltage is 240 V dc and the transformer initial magnetizing current is 0.4 A. The power MOSFET is operating at a frequency of 50 kHz with a duty cycle of 0.4. Determine the transformer turns ratio from primary to secondary and its inductance. Assume ideal components and no ripple in load voltage. Find also the open circuit voltage across the semiconductor device. (6)

Q.3 Attempt any three from the following. (18)

(a) In a step up converter, the duty ratio is adjusted to regulate the output voltage at 48 V. The input voltage varies in a range from 12 to 36 V. The maximum power output is 120 W. For stability reasons, it is required that the converter always operate in a discontinuous current conduction mode. The switching frequency is 50 kHz. Assuming ideal components and C as very large, calculate the maximum value of L that can be used.

(b) **(i)** Critically compare the static (semiconductor based) voltage regulators with that with conventional voltage regulators like capacitors, inductors or synchronous condensers.
(ii) What is UPQC ? Show the schematic (diagram) of it.

(c) Explain the control strategy for the converters of the HVDC transmission to control the power flow between two terminals.

(d) Distinguish between Online UPS and Standby UPS. Also with a one line diagram, explain the working of Online UPS.

(e) Write a brief note on the design considerations, with respect to cross regulation minimization and voltage regulation, for multiple output SMPS.

Q.4 (a) An HVDC transmission system is rated at 500 MW, $\pm$ 250 kV and the converter uses 12-pulse converter arrangement. Determine the RMS current and peak reverse voltage of each thyristor. (5)

(b) Write a brief note on eliminating the harmonics from the output voltage of the inverters. (7)

OR

Q.4 (a) A thyristor controlled reactor (TCR) installed at a bus with a voltage of 240 V has values for C and L of 200 μF and 0.0507 H respectively. The in-phase component of the current remains at 12 A throughout the range. Determine (i) the range of the current that can be compensated and (ii) the value of the firing angle required to compensate a current of 12-j11 A. (6)

(b) With neat diagram, discuss the working of a scheme that provides instantaneous VAR control. (6)

Section – II

Q.5 Attempt any three from the following. (18)

(a) Describe the regenerative and dynamic braking of a chopper controlled separately excited motor with appropriate waveforms.

(b) Describe synchronous motor drive employing load commutated inverter.

(c) A dc chopper is used for rheostatic braking of a separately excited dc motor. The braking resistance is 5 Ω. The motor has R_a= 0.05 Ω and back emf constant is K_v = 1.527 V/A-rad/s. The average armature current during braking is kept constant at 150 A with negligible ripple. The field current is 1.5A. For a duty ratio of 40 % for a chopper determine

(i) Average voltage across switch
(ii) power dissipated in braking resistor
(iii) equivalent load resistance of motor
(iv) motor speed.

(d) Draw and explain the speed torque characteristics of a dc separately excited motor fed from single phase fully controlled ac-dc converter operating at various firing angles. Clearly show the continuous and discontinuous mode operation on the speed-torque characteristics.

(e) A 440V, 50 Hz, 6 pole, Y connected wound rotor motor has the following parameters. $R_s = 0.5\ \Omega$, $R_r' = 0.5\ \Omega$, $X_s = X_r' = 1.2\ \Omega$, $X_m = 50\ \Omega$
Stator to rotor turns ratio is 3.5.
Motor is controlled by static rotor resistance control. External resistance is chosen such that the breakdown torque is provided at standstill for a duty ratio of zero. Calculate the value of external resistance. How duty ratio should be varied with the speed so that the motor accelerates at maximum torque.

Q.6 (a) Draw and explain the working of DC coupled drive circuit for switching a power BJT. The circuit should have bipolar output. How will you modify the circuit to achieve a faster turn off of BJT. **(8)**

(b) Draw and explain a gate driver circuit for firing a low speed/low-switching frequency MOSFET. **(4)**

OR

Q.6 (a) Compare MOSFET with BJT with respect to their construction, ratings available, switching characteristics, switching speeds and applications. **(8)**

(b) Draw and explain the I-V characteristics of BJT. **(4)**

Q.7 (a) Performance of IGBT is midway between BJT and MOSFET. Justify the statement. **(2)**

(b) List the disadvantages of the static slip power recovery scheme. **(2)**

(c) Which device suffers from secondary breakdown problem ? Why ? **(2)**

(d) Why it is easy to parallel MOSFET's than that of BJTs ? **(2)**

(e) What is slip speed ? Plot the variation of slip speed with respect to speed (or normalized speed). Explanation is not required for the plot. **(2)**

Q.8 (a) A four pole, 10 hp, 460 V motor is supplying its rated power to a centrifugal load at a 60-Hz frequency. Its rated speed is 1746 rpm. Calculate its speed, slip frequency and slip when it is supplied by a 230 V, 30 Hz source. Centrifugal load is fan type load. **(5)**

(b) Show the schematic for the closed loop speed control of DC separately excited motor. Explain only the inner current loop and field weakening part of the scheme. **(5)**