UNIVERSITY OF SWAZILAND

MAIN EXAMINATION 2005/2006

FACULTY OF SCIENCE

DEPARTMENT OF ELECTRONIC ENGINEERING

TITLE OF PAPER: ELECTRONICS III—PAPER 2

COURSE NUMBER: E510

TIME ALLOWED: THREE HOURS

INSTRUCTIONS:

1. Answer any FOUR (4) of the following six questions.
2. Each question carries 25 marks.
3. If you think not enough data has been given in any question you may assume reasonable values.

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THIS PAPER CONTAINS SEVEN (7) PAGES INCLUDING THIS PAGE

QUESTION 1

(a) A three-phase, 400-V motor rated 75 KW is loaded at 80% of its rating. The motor is 90% efficient at this load and operates at a power factor of 0.85 lagging. What is the line current for the motor?

[9 MARKS]

(b) A three-phase, Y-connected, 400 V, 1450 RPM, 60 KW induction motor has the following equivalent circuit parameters per phase: $R_s = 0.075\ \Omega$, $R_r = 0.06\ \Omega$, $X_s = 0.63\ \Omega$, $X_r = 0.94\ \Omega$, $X_m = 19.5\ \Omega$.

(i) Calculate the no-load current (assume $n_r = n_s$ at no-load).

[6MARKS]

(ii) Calculate the line current when the motor develops rated KW at rated speed.

[10 MARKS]

QUESTION 2

(a) A shunt field DC motor is rated 1000 W, 48 V, 2400 RPM, and draws 25 A when operating at rated conditions. The field rheostat is adjusted so that the stator flux per pole is reduced by 10%, and the load is adjusted so that the armature current is 18 A. Find the new operating speed of the motor. The shunt field has a resistance of 25 Ω, and the armature winding has a resistance of 0.5 Ω.

[11 MARKS]

(b) The electrical specifications of a 230 V(ac), split-phase induction motor are as follows: $R_{mw} = 4\ \Omega$, $R_{aw} = 8\ \Omega$, $X_{mw} = j10\ \Omega$, $X_{aw} = j12\ \Omega$.

(i) Calculate the magnitude and angle of the locked-rotor current.

[7 MARKS]

(ii) Specify a capacitor that, when added to the auxiliary winding, will cause the motor to develop maximum starting torque.

[7 MARKS]

QUESTION 3

(a) A permanent-magnet generator has 100 turns in the coil, and the permanent magnets provide a flux per pole of 0.05 Wb. What is the required rotational speed of the coil (in RPM) to generate 250 V_{rms}?

[10 MARKS]

(b) A three-phase synchronous generator is connected to an infinite bus at 11 KV (line-to-line), 50 Hz. The generator has a synchronous reactance of 1.4 Ω per phase and negligible armature resistance. The machine is operating with an output of 75 MVA at 0.9 power factor, lagging. Find the internal generated voltage and power angle. Draw a phasor diagram showing the terminal voltage as the reference voltage, the generated voltage, the armature current, and the voltage drop across the synchronous reactance.

[15 MARKS]

QUESTION 4

(a) The turn-on and turn-off current and voltage waveform on an IGBT switch with an inductive load are shown in Fig Q4a. The circuit is switched at 50% duty cycle at 40 KHz. The IGBT has $V_{CE(on)}$ rating of 2.5 V, $t_{d(on)}$ = 50 ns, and $t_{d(off)}$ = 400 ns. Determine the average power dissipation in the IGBT.

[15 MARKS]

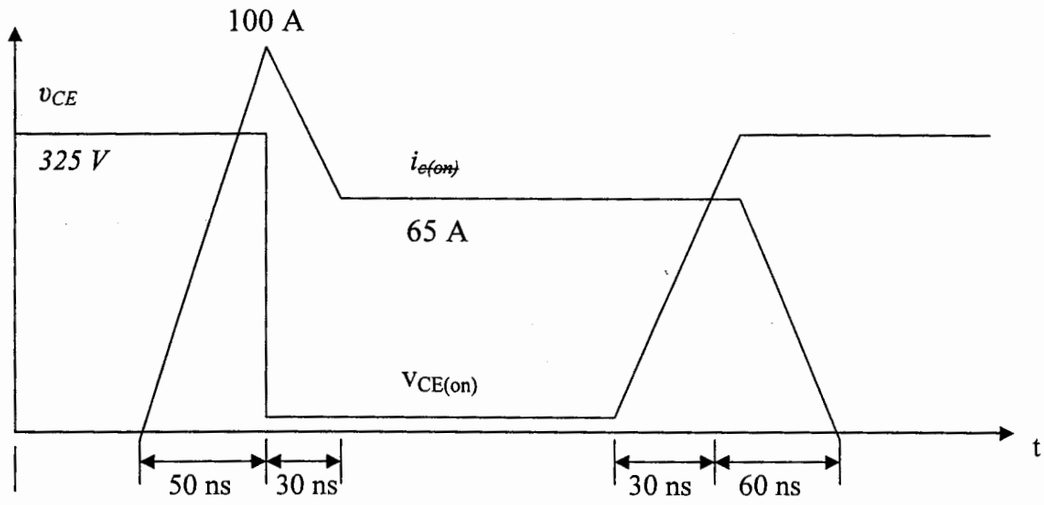

Fig Q4a

(b) Select the components of the snubber circuit of Fig. Q4b. The supply voltage V_s = a step of dc voltage 350 V. The thyristor powers a 10-Ω resistive load R. R_s should limit the maximum current through the capacitor to 350 A. The maximum permitted values of di_T/dt and dv_T/dt are 250 A/μs and 350 V/μs respectively. Ignore the switching times.

[10 MARKS]

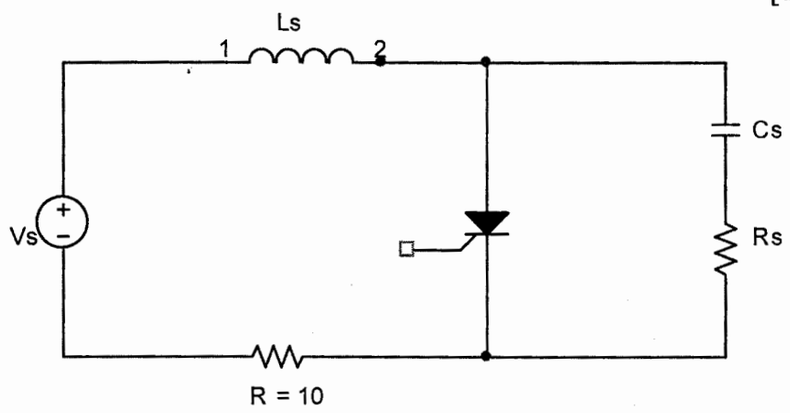

Fig Q4b

QUESTION 5

(a) A boost converter operating in continuous conduction mode has the following parameters:

$V_s = 5$ V $L = 300$ μH $R_L = 20$ Ω $C = 330$ μF $f_s = 25$ KHz $D = 0.35$

(i) Determine V_o.
(ii) Sketch the inductor current i_L.
(iii) Determine the peak-to-peak voltage ripple in the output.

[12 MARKS]

(b) In a full-bridge converter, the duty ratio is adjusted to regulate the output voltage to 12 V. The input dc voltage varies in the range 20 V to 30 V. The converter is switched at 80 KHz. Find the range of pulse width of the switching waveform applied at the switch.

[13 MARKS]

QUESTION 6

(a) A full-bridge inverter with square-wave switching operates with D = 0.8, f_s = 50 Hz, V_s = 400 V, provides power to a load of 10 Ω in series with 10 mH. Determine the voltage transfer ratio.

[10 MARKS]

(b) A three-phase, 50 Hz induction motor is rated 50 KW, 1460 RPM. The motor is driven by a variable-frequency drive. What are the rated torque and power for the motor when operating at 20 Hz? What would the expected full-load speed be?

[15 MARKS]