KAFRELSHEIKH UNIVERSITY
FACULTY OF ENGINEERING
TIME ALLOWED: 3 HOURS

ELECTRICAL ENGINEERING DEPT. 3rd YEAR
FINAL EXAM OF 1ST SEMESTER 2015-2016
POWER ELECTRONICS [1]

The maximum mark for the examination paper is 90 marks, and the mark obtainable for each part of a question is shown in brackets alongside the question.

Instructions to the candidates:

- Clarify your answer with the suitable sketches as you can.
- Please use a pen or heavy pencil to ensure legibility.
- Please attempt all questions.

QUESTION NUMBER ONE [45 MARKS]

1. Make a list of uncontrolled and controllable switches. Then, derive the approximate equivalent circuit of an IGBT from its structural details. Afterward, explain how it differs in features from power MOSFET. [8 Marks]
2. A power transistor is used as a switch. The various parameters of the transistor circuit are: $V_{CC}=220$ V, $V_{CES}=2.5$ V, $I_{CS}=60$ A, $t_d=0.5$ μs, $t_r=1$ μs, $t_n=40$ μs, $t_s=4$ μs, $t_f=3$ μs, $t_o=30$ μs, $f=10$ kHz. Collector to emitter leakage current is 1.5 mA. Determine average power loss during t_{on} and t_n. Find also the peak instantaneous power loss during turn on time. [10 Marks]
3. It has been stated that as the number of pulses per cycle are increased, the output DC wave form get improved. Explain. [8 Marks]
4. A single phase half wave rectifier feeds power to (i) RL load and (ii) RL load with freewheeling diode across it. Describe the working of this rectifier for both these parts with relevant waveforms and bring out the differences if any. Hence point out the effect of using a freewheeling diode. [9 Marks]
5. A full wave bridge rectifier is used to charge a battery of 24 V with a capacity of 120 Wh. If the supply voltage with 220V is used to feed the full wave bridge rectifier circuit with 4 : 1 transformer, find:
   A. The diode conduction angle;
   B. The value of limiting resistance for 10 A (DC current) flows through the battery;
   C. The charge time in hours;
   D. The power losses through the limiting resistor; and
   E. The rectifier circuit efficiency. [10 Marks]

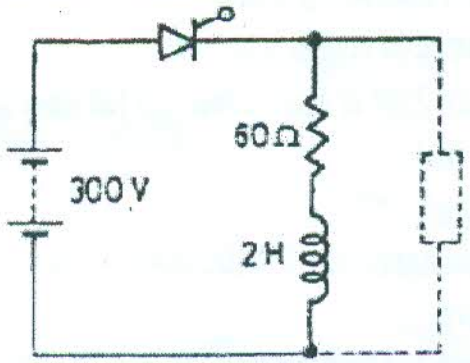
Turn the page to see the rest of the questions

QUESTION NUMBER TWO [30 MARKS]

1. Justify the statement, "higher the gate current, lower the forward break over voltage. Hereafter, enumerate the various mechanisms by which thyristor can be triggered into forward conduction mode. [8 Marks]
2. Sketch switching characteristics of a thyristor during its turn-off process. Indicate clearly the various intervals into which turn-off times can be subdivided. Discuss briefly the nature of these curves. [6 Marks]
3. Snubber circuit for an SCR should primarily consist of capacitor only. But, in actual practice, a resistor is used in series with the capacitor. Discuss. [8 Marks]
4. A thyristor protection circuit with L and R_S, C_S controlling the power in a load resistance R_L. The supply voltage is 240 V dc and the specified limits for di/dt and dv/dt for the SCR are 50 A/μsec and 300 V/μsec respectively. Determine the values of the di/dt inductance and the snubber circuit parameters R_S and C_S. [8 Marks]

QUESTION NUMBER THREE [15 MARKS]

1. A single controlled rectifier controls the current to a resistive load in a single phase sinusoidal circuit. Derive expressions for the average value and r.m.s value of the load current at an arbitrary firing angle α. What is the lowest value of ripple factor for this system? Sketch the variations of I_{av} and $I_{r.m.s}$ versus firing angle. [7 Marks]
2. In the circuit of below figure, the thyristor is gated with a pulse width of 40 μsec. The latching current of thyristor is 36 mA. For a load of 60 Ω and 2 H, will the thyristor get turned on? Check. If the answer is negative, how this difficulty can be overcome for the given load. Find the maximum value of the corrective parameter shown dotted. [8 Marks]



Good Luck [Instructor: Hamdy K. Al-Moniar]