B.Sc. Engg. (EE). 5th Sem.
B.Sc. TE (2-Yr), 1st Sem.

Date: 08 December , 2023 (Morning)

ISLAMIC UNIVERSITY OF TECHNOLOGY (IUT)
ORGANISATION OF ISLAMIC COOPERATION (OIC)

DEPARTMENT OF ELECTRICAL AND ELECTRONIC ENGINEERING

Semester Final Examination   Winter Semester, A. Y. 2022-2023
Course No.: EEE 4503/EEE 4591   Time: 3 Hours
Course Title: Industrial Electronics/Power Electronics   Full Marks: 150

Answer **all 6 (six)** questions (Note that Q. 6.b) has an option). All questions carry equal marks. Marks in the margin indicate full marks. Programmable calculators are not allowed. Do not write on this question paper. Assume reasonable value for any missing data. Marks of each question and corresponding COs and POs are shown in brackets.

1 a) "Power Electronic devices introduces high THD and low power factor". Explain the statement with an example of a power converter. | 12 [CO1, PO1]

b) (i) Explain why reverse recovery phenomenon is considered as a critical factor if one wants to use semiconductor devices as switches.
   (ii) After applying a reverse bias, the slope of the falling current of a semiconductor power diode has been calculated as 50 A/µs. The current changes its slope from positive to negative after 2µs from the zero crossing. The total charge accumulated during the reverse recovery process is 150 µC. Calculate the peak reverse current and softness factor.
   (iii) Can you use the approximation formula to solve this problem? Why? | 13 [CO2, PO2]

2 a) The input voltage of the following converter is 230 V (rms), at a frequency of 50 Hz. The load current is 10 A dc. If the power supplied to the load is 1.5 kW, (i) determine the firing angles for T_1 and T_2, (ii) sketch the waveshapes of i_s and V_p, (iii) compare output voltage waveshapes with D_m and without D_m. | 13 [CO2, PO2]

Fig. Q. 2. a)
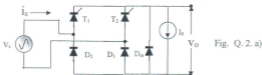
b) (i) Sketch the circuit diagram of practical thyristor converter (ii) sketch the waveforms of input voltage, output voltage and output current for both continuous and discontinuous current conduction (iii) determine average value of output voltage if thyristor one is fired at 60°, α=314 rad/sec, dc output current I_d=10 A, rms input voltage V_s=230 V, input inductance L_s=10 mH. | 12 [CO2, PO2]

3 a) Depict the circuit diagram of a three bridge rectifier. Sketch line to line voltage, output voltage, line current and diode current. Identify the devices operating in various portion of the voltage. Formulate the dc and rms value of the output voltages. | 12 [CO1, PO1]

b) With a circuit diagram, explain how a controlled rectifier can feed the power from the load side to the input. | 13 [CO1, PO1]

4 a) (i) Explain why unidirectional ac controllers are rarely used.
   (ii) Identify the main problems of using two thyristors in a bidirectional converter whose thyristors' cathodes are not common. Propose a suitable circuit to overcome this problem.
   (iii) If the supply voltage of an ac controller is 220 V (rms) 50 Hz, what will be the firing angle's expression order to get to have 100 V (rms) output voltage for a resistive load? | 12 [CO2, PO2]

b) A single-phase full-wave ac controller with an R-L load is supplied with an rms voltage $V_S=120$ V, f=60 Hz. The load inductance is L=6.5 mH. The thyristors are fired at $\alpha_1=60^0$ and $\alpha_2=\alpha+60^0$, respectively. The thyristor 1 ceases conduction at $\beta=240^0$. 06 [CO2, PO2]
  (i) Determine the value of load resistance?
  (ii) For this load, if α_1 is made less than 60^0 what will be the output voltage of the controller?

c) An ac controller has a resistive load of R=10 Ω and the input is 220 V, 50 Hz. The thyristors switch is on for n=25 cycles and for m=75 cycles, respectively Determine 07 [CO2, PO2]
  (i) the rms value of the output voltage
  (ii) the input power factor
  (iii) the average and rms current through thyristors.

5 a) (i) The CUK converter has a distinct feature that makes it superior over the conventional buck-boost converter. Explain the feature. (ii) Depicting the circuit diagram of the CUK converter, describe the operating principle for ON and OFF modes of power switch. (iii) Equating the volt-radian of inductors, find the expression of output voltage. 13 [CO1, PO1]

b) A buck-boost regulator has an input voltage $V_s=12$ V. The duty cycle k=0.5, the switching frequency is 25 kHz. The average voltage, $V_a=15$ V and the average load current, $I_a=1.5$ A and the switching frequency is 20 kHz. For inductance, L=250 μH and filter capacitance, C=440 μF, find (i) average output voltage (ii) the ripple current of inductor (iii) the ripple voltage of the filter capacitor (iv) critical value of L and C. 12 [CO2, PO2]

6 a) An on-line UPS is supplying a power to an ac load with a current of $I=200 \sin(wt-45^0)$. A battery of dc voltage 220 V is used in this UPS. Explain what kind of converter you need to supply the ac load. Sketch its circuit diagram and Identify the swiching states in a table of the above converter to supply the load. Determine the fundamental magnitude of the power. 13 [CO1, PO1]

b) Can the following converter be used in an industry to run an induction motor? Briefly describe how three phase voltage can be obtained using the technique of 180^0 degree conduction. 12 [CO1, PO1]
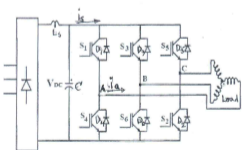
OR

b) Describe the working principle of an induction heater coupled with an inverter. Write some of the industrial applications of induction heating 12 [CO1, PO1]

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