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**PRESIDENCY UNIVERSITY
BENGALURU**

SET A

**SCHOOL OF ENGINEERING
END TERM EXAMINATION - JAN 2024**

Semester : Semester V - 2021

Course Code : EEE2019

Course Name : Power Electronics

Program : B.Tech.

Date : 04-JAN-2024

Time : 9:30AM - 12:30 PM

Max Marks : 100

Weightage : 50%

Instructions:

- (i) Read all questions carefully and answer accordingly.
- (ii) Question paper consists of 3 parts.
- (iii) Scientific and non-programmable calculator are permitted.
- (iv) Do not write any information on the question paper other than Roll Number.

PART A

ANSWER ALL THE QUESTIONS

5 X 2M = 10M

1. While designing a Chopper for a battery operated vehicle, the features of high input impedance and low on state power loss are desirable. Suggest the suitable semiconductor device which is suitable in the power converter (C.O.NO 1) [Knowledge]
(CO1) [Knowledge]
2. In a wood cutting application, A DC shunt motor is controlled by a single phase controlled rectifier. The supply specifications are Single phase 230V, 50Hz. The motor specifications are $R_a=10\text{ohms}$, $L_a=1\text{mH}$ and $E_b=100\text{V}$. Compute the minimum firing angle of the rectifier.
(C.O.NO 2) [Knowledge]
(CO2) [Knowledge]
3. WAP4 electric engine uses a DC series motor to haul the passenger trains in Indian Railways. Assume the DC series motor is controlled by a step up chopper, if the input voltage to a chopper is 375V DC. Compute the minimum voltage of the chopper?
(CO3) [Knowledge]
4. A single phase induction motor is used as a blower for industrial applications. The specifications of the motor are 230V, 50Hz, $R=10\text{ohms}$ and $L=10\text{mH}$. The motor is controlled by a single phase fullwave AC Voltage regulator. Assume the suitable control technique and compute the impedance angle?
(CO3) [Knowledge]
5. In an oil mill, a centrifugal pump is controlled by a single phase full bridge inverter to pump the liquid. The input voltage of a single phase full bridge inverter is 440V DC. What would be the RMS value of output voltage?
(CO4) [Knowledge]

PART B

ANSWER ALL THE QUESTIONS

5 X 10M = 50M

6. 1. A VS-VSK.230.PbF series SCR datasheet is provided to design a firing circuit to turn on the SCR. The specifications are as follows

Maximum average on state current at 850 C is 230A

Low level of thresh hold voltage – 1.03V

High level of thresh hold voltage - 1.08V

Maximum on state voltage drop - 1.59V

Maximum holding current -500mA

Maximum latching current- 1000mA.

Minimum gate pulse width-100 μ Sec

Gate pulse voltage-10V

For an application, If the SCR represented in data sheet is failed to trigger when the gate pulse magnitude of 10V and gate pulse width of 80 μ sec are applied when connected to a load of L= 2H and DC source voltage of 200V. Identify the problem to trigger the SCR and suggest the value of minimum gate pulse width required to trigger the SCR and compute pulse width if R=20ohms and L=0.2H.

(CO1) [Comprehension]

7. A 220V, 10A, 1300rpm DC shunt motor used for wood cutting application delivers constant load current and its armature resistance is 1 Ω , inductance is 2mH and back e.m.f is 110V. The motor is controlled by a single phase fully controlled rectifier fed from 1- ϕ , 230V, 50Hz supply. While carving a wooden piece at rated torque, T1 and T2 are fired at $\alpha=10^\circ$. It is found that the thyristors couldn't be fired at that angle and successfully triggered for the values of firing angles greater than 20 $^\circ$.

1. Identify the problem in rectifier control circuit and determine the firing angle for obtaining rated torque.

2. Discuss the value of firing angle at rated torque when back emf is reversed.

(CO2) [Comprehension]

8. A 30A, 470V and 875rpm Crompton DC shunt motor is used in steel rolling mills for coiler operation. This motor is controlled by three phase fully controlled converter. The value of armature winding resistance is 1 Ω and inductance is 1mH. The supply specifications are 3- ϕ , 440V, 50 Hz supply. It is required to rolling the sheet by rotating the spindle at a speed of 600 rpm. It is observed that the spindle is rotating in anti clock wise direction.

i) What would be the problem in firing circuit? 5M

ii) Compute the firing angle at rated torque and at a speed of -800rpm

(CO2) [Comprehension]

9. A fan manufacturing company has produced two types of fans i.e Type A and Type B. As per the Indian Standard Institute (ISI) norms, i.e IS: 374-1979. Type A fan regulator shall be capable of reducing the fan speed at least 30% of the rated speed and the Type C fan regulator (AC Voltage controller) shall be capable of reducing the fan speed at least 50% of the rated speed. Suggest the suitable AC Voltage controller for TypeA & B fans and the minimum firing angle of the converter too. Compute the rms value of out put voltage at the firing angle of 30 degrees for both the converters.

(CO3) [Comprehension]

10. A battery operated vehicle is controlled by a chopper and is connected to separately excited DC motor. The battery pack is made up of Li-Ion of voltage 300V DC. The motor specifications are 220V, 950 rpm, 30A and Armature resistance of 0.05 ohms. It is required to operate in first quadrant of speed and torque plane. Suggest the type of chopper and the maximum value of duty cycle for the DC-DC converter. Compute the duty cycle, if it is required to rotate at the speed of 800rpm and rated torque.

(CO3) [Comprehension]

PART C

ANSWER ALL THE QUESTIONS

2 X 20M = 40M

11. A single phase AC Voltage controller is fed with 230V, 50 Hz supply and is connected to a 1 kW, 230V heater. Assume the power controllers as unidirectional and bidirectional AC Voltage controllers. Calculate and compare the following parameters of both the controllers

1. Range of voltage control
2. RMS value of output voltages at the firing angle of 45°
3. Output power at the firing angle of 45°
4. Input power factor at the firing angle of 45°

(CO3) [Application]

12. A fan is connected to a single phase full bridge inverter which has square wave output. At the time of running, it is producing a lot of noise (Not of bearings). Single phase 230 V is fed to the motor.

1. Identify the reason for the noise
2. Compute the supply input voltage
3. Compute the magnitude of fundamental and Fifth order voltage harmonics
4. Express the magnitude of fifth order harmonic as % of fundamental voltage
5. Compute distortion factor and %THD

(CO4) [Application]