PRESIDENCY UNIVERSITY
BENGALURU

SCHOOL OF ENGINEERING
END TERM EXAMINATION - JAN 2023

Semester : Semester V - 2020   **Date :** 9-JAN-2023
Course Code : EEE2019   **Time :** 9.30AM - 12.30PM
Course Name : Sem V - EEE2019 - Power Electronics   **Max Marks :** 100
Program : B.Tech. Electrical and Electronics Engineering   **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.

PART A

ANSWER ALL THE TEN QUESTIONS   **10 X 2 = 20M**

1. Silicon Controlled Rectifier (SCR) is a unidirectional semiconductor device made of silicon. An SCR is considered to be a semi-controlled device because_____
   a) It can be turned OFF but not ON with a gate pulse   (CO1) [Knowledge]
   b) It conducts only during one half-cycle of an alternating current wave
   c) It can be turned ON only during one half-cycle of an alternating voltage wave
   d) It can be turned ON but not OFF with a gate pulse

2. Power electronics converters mainly comprise of solid-state switches, such as Power MOSFET, Power BJT, IGBT, Thyristors etc., and lossless components, namely inductors and capacitors to control and convert the electric power. If the available power supply is single phase ac, the power converters suitable in control of single phase induction motors are_____
   a) Rectifiers   (CO1) [Knowledge]
   b) Inverters
   c) Choppers
   d) AC Voltage Controllers

3. A power MOSFET is a specific type of metal–oxide–semiconductor field-effect transistor (MOSFET) designed to handle significant power levels. Compared to the other power semiconductor devices, such as an insulated-gate bipolar transistor (IGBT) or a thyristor, it's main advantages are high switching speed and good efficiency at low voltages. A power MOSFET is _____ controlled device.

a) Current   (CO1) [Knowledge]

b) Voltage

c) Both Current and Voltage

d) None of these

4. A single phase full-converter using R load is a _____ quadrant converter and that using an RL load without FD is a _____ quadrant converter.

a) One, One   (CO2) [Knowledge]

b) Two, One

c) One, Two

d) Two, Two

5. A single phase controlled rectifier is used to roll steel sheets. In this case, it is required to rotate the motor in the anti-clock wise direction too. The firing angle of the converter in the above case can be _____.

a) 30 degrees   (CO2) [Knowledge]

b) 70 degrees

c) 120 degrees

d) Both 1) & 2)

6. A single phase half wave controlled rectifier is fed from 230V, 50Hz supply. The maximum value of average output voltage of the converter is _____.

a) 103.5V   (CO2) [Knowledge]

b) 51.8V

c) 325.3V

d) 230V

7. A single phase full wave AC voltage controller is connected to an electric heater of 1kW and is controlled by using phase control technique. _____ is the minimum value of rms output voltage, if the supply voltage is single phase 230V, 50Hz supply.

a) 102V   (CO3) [Knowledge]

b) 12.6V

c) 0V

d) 162.6V

8. Cycloconverters find wide applications in high power ac drives. A cycloconverter is a _____

a) One stage power converter   (CO3) [Knowledge]

b) One stage voltage converter

c) One stage frequency converter

d) None of the mentioned

9. In pulse width modulated inverters, the output voltage is controlled by controlling the _____

a) Input frequency   (CO4) [Knowledge]

b) Modulating index

c) Amplification factor

d) None of the mentioned

10. Pulse width modulation (PWM) is a modulation technique that generates variable-width pulses to represent the amplitude of an analog input signal. In multiple pulse width modulation technique, the square wave is the _____ signal whereas the triangular wave is the _____ signal.

   a) Reference, Carrier   (CO4) [Knowledge]

   b) Base, Reference

   c) Carrier, Reference

   d) None of the mentioned

PART B

ANSWER ALL THE FOUR QUESTIONS   4 X 10 = 40M

11. In a variable speed drive used for traction purpose, three phase inverter is used to control the speed and torque characteristic of induction motor. The inverter is operated using carrier based PWM techniques where the carrier frequency is greater than 100 kHz. Suggest the suitable semiconductor switching device in the design of Inverter. Also, discuss the steady state and switching characteristics of the particular semiconductor device.

                                                                (CO1) [Comprehension]

12. A 220V, 10A, 1300rpm DC shunt motor used for wood cutting application delivers constant load current and its armature resistance is 1Ω, 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 α=10°. 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°.

   a. Identify the problem in rectifier control circuit and determine the firing angle for obtaining rated torque.
   b. Discuss the value of firing angle at rated torque when back emf is reversed.

                                                                (CO2) [Comprehension]

13. A step down chopper is used in a battery charger which has an internal resistance of R=5Ω.The input voltage of the chopper is 220V. When the chopper remains on, the voltage drop is Vch =2V and the chopping frequency is f=1 kHz. If the duty cycle is 60%, determine:

   a. The average output voltage
   b. The RMS output voltage
   c. The converter efficiency
   d. The chopper on time TON

                                                                (CO3) [Comprehension]

14. The full-bridge pulse-width-modulation (PWM) single-phase inverter is widely used in uninterruptable power supplies (UPS), wind and solar power dc-ac interfacing, stand-alone voltage regulators in distributed power systems, and many other applications. The main goal of it's control system is to achieve a fast dynamic ac voltage and frequency regulation during transients, while featuring zero steady-state error when operating under different types of loads. Explain any three voltage control methods of single phase full bridge inverters and identify the most preferred one with justification.

                                                                (CO4) [Comprehension]

ANSWER ALL THE TWO QUESTIONS   **2 X 20 = 40M**

15. 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

    a. Range of voltage control
    b. RMS value of output voltages at the firing angle of 45°
    c. Output power at the firing angle of 45°
    d. Input power factor at the firing angle of 45°

                                                          (CO3) [Application]

16. 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.

    a. Identify the reason for the noise
    b. Compute the supply input voltage
    c. Compute the magnitude of fundamental and Fifth order voltage harmonics
    d. Express the magnitude of fifth order harmonic as % of fundamental voltage
    e. Compute distortion factor and %THD

                                                          (CO4) [Application]

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