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Question Paper Code: R5301

B.E. / B.Tech. DEGREE EXAMINATION, NOV 2025

Fifth Semester

Electrical and Electronics Engineering

R21UEE501 – POWER ELECTRONICS

(Regulations R2021)

Duration: Three hours

Maximum: 100 Marks

Answer ALL Questions

PART A - (10 x 1 = 10 Marks)

1. What is the role of a gate drive circuit in a MOSFET? CO1 - U
(a) Increase output voltage (b) Provide isolation
(c) Turn the device on/off (d) Reduce conduction losses
2. Which commutation method uses an auxiliary circuit to turn off a thyristor? CO1 - U
(a) Voltage commutation (b) Natural commutation
(c) Forced commutation (d) Phase commutation
3. Explain the function of freewheeling diode in phase-controlled converter CO1 - U
(a) Blocks reverse voltage (b) Increases conduction time
(c) Provides path for inductive load current (d) Enhances output power
4. What is the major application of a 2-pulse converter? CO1 - U
(a) Motor speed control (b) UPS
(c) Light dimmer (d) Welding
5. Which converter type increases output voltage? CO1 - U
(a) Boost (b) Buck (c) Buck-boost (d) All of the above
6. In a chopper, what defines the output voltage? CO1 - U
(a) Switching device (b) Duty cycle
(c) Load resistance (d) Inductance

7. What is the purpose of dead-time in an inverter? CO1 - U
 (a) To increase conduction time (b) To prevent shoot-through
 (c) To enhance output frequency (d) To reduce gate drive power
8. In single-phase inverters, which waveform shape is most ideal for induction motor operation? CO1 - U
 (a) Square wave (b) Modified sine wave (c) Sinusoidal PWM wave (d) Step wave
9. What is the main drawback of cycloconverters? CO1 - U
 (a) High-frequency switching (b) Poor output voltage regulation
 (c) High harmonic content (d) Inability to handle large loads
10. Which converter provides variable frequency output from a fixed frequency source? CO1 - U
 (a) AC chopper (b) Phase-controlled controller
 (c) Cyclo converter (d) Line commutated converter

PART – B (5 x 2= 10 Marks)

11. Explain the turn-on characteristics of a thyristor with a neat sketch CO1 - U
12. Interpret how firing angle affects the average output voltage in an R-load converter. CO1 - U
13. Demonstrate the current waveform in a boost converter operating in CCM. CO1 - U
14. Illustrate the PWM technique used for harmonic reduction. CO1 - U
15. Classify AC-AC converters based on their frequency change capability. CO1 - U

PART – C (5 x 16= 80 Marks)

16. (a) Analyze the switching behavior and thermal constraints of IGBT and MOSFET when operating under similar voltage and current conditions. Include switching waveforms and discuss gate control implications. CO3 - Ana (16)
- Or
- (b) Compare and contrast the static and dynamic characteristics of BJT, MOSFET, and IGBT. Interpret their switching limitations and suitability for different converter configurations. CO3 - Ana (16)

17. (a) Examine the harmonic spectrum of a single-phase full converter operating at different firing angles with an RL load. Discuss how inductance affects the harmonic content and suggest mitigation strategies. CO3-Ana (16)
- Or
- (b) Compare the performance of a half-controlled and fully controlled converter in terms of average output voltage, power factor, and suitability for regenerative braking applications. CO3 Ana (16)
18. (a) Apply the operation of a buck converter to charge a 12V battery from a 24V source. Design the converter with suitable components, duty cycle, and inductor value. CO2 App (16)
- Or
- (b) Demonstrate the working of a boost converter used in battery-powered vehicles. Include analysis of current and voltage waveforms during steady-state operation. CO2 -App (16)
19. (a) Calculate the RMS value of the line voltage for a star-connected load when the VSI operates in 120° conduction mode, assuming a DC input voltage of V_{dc} . CO2 - App (16)
- Or
- (b) Identify the fundamental component of the phase voltage for a delta-connected load when the VSI operates in 180° conduction mode. CO2 - App (16)
20. (a) Apply phase angle control in a single-phase AC voltage controller to regulate power to a resistive heating element. Draw the circuit diagram, waveforms, and calculate RMS output voltage for a given firing angle. CO2 - App (16)
- Or
- (b) Demonstrate the working of a three-phase cycloconverter for a variable-frequency synchronous motor drive. Illustrate the gate signals, output waveforms, and explain how reversal of frequency is achieved. CO2 - App (16)

