

NAME OF THE EXAMINATION: B.E. POWER ENGINEERING SECOND YEAR SECOND SEMESTER
- 2023

SUBJECT: DIGITAL AND POWER ELECTRONICS

TIME: 3 HOURS

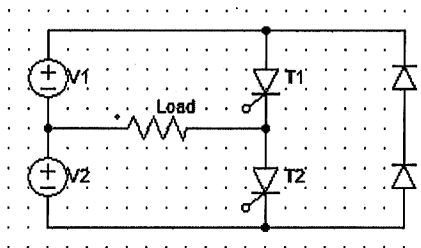
FULL MARKS: 100

Answer *ALL* questions

1. Choose the correct option for any *TEN* questions: (10@1 = 10)
- (i) When binary 11110 is divided by binary 101, the quotient in binary is: [CO1]
 a) 111
 b) 101
 c) 110
 d) 1100
- (ii) Represent $(-37)_{10}$ in 8-bit signed 2's complement form [CO1]
 a) 1010 0101
 b) 1101 1011
 c) 1101 1010
 d) 1010 1101
- (iii) A NOR gate is ON only when all its inputs are [CO1]
 a) High
 b) Positive
 c) ON
 d) OFF
- (iv) The truth table for an S-R flip-flop has how many VALID entries? [CO2]
 a) 1
 b) 2
 c) 3
 d) 4
- (v) The group of bits 10110111 is serially shifted (right-most bit first) into an 8-bit parallel output shift register. The shift register already has an initially stored content of 11110000. After two clock pulses, the register contains [CO2]
 a) 11110000
 b) 11111100
 c) 10110111
 d) 10111000
- (vi) The minimum number of flip-flops required to construct a MOD-64 (divide by 64) ripple counter, are _____ [CO2]
 a) 4 flip-flops
 b) 6 flip-flops
 c) 16 flip-flops
 d) 64 flip-flops
- (vii) DTL logic family employs: [CO2]
 a) diode and transistors
 b) diode and resistor
 c) resistors and transistors
 d) diodes, resistors and transistors
- (viii) A TRIAC is a [CO3]
 a) 2 terminal switch
 b) 3 terminal switch
 c) 2 terminal bilateral switch
 d) 3 terminal bidirectional switch
- (ix) The two-transistor model of the SCR can be obtained by: [CO3]
 a) Bisecting the SCR vertically
 b) Bisecting the SCR horizontally
 c) Bisecting the SCRs middle two layers
 d) Bisecting the SCRs top and bottom layers

[Turn over

- (x) In a thyristor snubber circuit, di/dt protection is achieved through the use of [CO3]
 a) R across thyristor
 b) RL across thyristor
 c) L in series with the thyristor
 d) RC across thyristor
- (xi) In a single-phase half-wave circuit with RL load and a freewheeling diode, the freewheeling period is [CO4]
 a) α to $\pi+\alpha$
 b) π to $2\pi+\alpha$
 c) 0 to π
 d) $\pi/2$ to $2\pi-\alpha$
- (xii) If the firing angle in an SCR rectifier is decreased, the output is [CO4]
 a) maximum
 b) increased
 c) decreased
 d) remain unaffected
- (xiii) At the output terminals of an AC line voltage controller, [CO5]
 a) variable ac with variable frequency is obtained
 b) variable dc with variable frequency is obtained
 c) variable ac with fixed frequency is obtained
 d) variable dc with fixed frequency is obtained
- (xiv) If $T=T_{on}+T_{off}$ is the time period for a chopper circuit and D is its duty cycle, then the chopping frequency is [CO5]
 a) D/T_{off}
 b) T_{off}/D
 c) T_{on}/D
 d) D/T_{on}
- (xv) In the following inverter circuit, what is the voltage across the R load when only the SCR T1 is conducting? [CO5]



- a) V_2
 b) $V_1 - V_2$
 c) $V_1 + V_2$
 d) V_1

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| 2 | (a) Convert $(105.15)_{10}$ to binary | (5) | [CO1] |
| | (b) Convert $(010111111011.011111)_2$ to Hexadecimal | (3) | [CO1] |
| | (c) Perform decimal addition $679.6 + 536.8$ using BCD 8421 code | (5) | [CO1] |
| | (d) Subtract 75 from 26 using 8 bit 2's complement arithmetic | (5) | [CO1] |
| OR | | | |
| 2 | (e) Why are NAND gate and NOR gates called universal gates? | (3) | [CO1] |
| | (f) Reduce the Boolean expression $Z = A[B + \bar{C}(AB + A\bar{C})]$. Draw the logic circuit that can be used to implement the simplified expression. | (5) | [CO1] |
| | (g) Write Boolean expression for the logic circuit shown and develop the truth table. | (3) | [CO1] |
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| | (h) Expand the following expression to a standard SOP form and hence find the minterms and maxterms: $F = A\bar{B} + A\bar{B}CD + CD + B\bar{C}D + ABCD$ | (7) | [CO1] |

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| 3 | (a) | What is the basic difference between a latch and an edge-triggered flip-flop? | (2) | [CO2] |
| | (b) | Draw and explain the operation of a Mod 4 Up/Down Ripple-counter using J-K flip flops | (5) | [CO2] |
| | (c) | What is shift register? Implement Parallel in Serial out (PISO) shift register using D flip flop. | (6) | [CO2] |
| | (d) | Draw and label the different internal parts of a 555 timer IC. | (5) | [CO2] |

OR

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| 3 | (e) | Draw the output waveform of an edge-triggered J-K flip flop for input sequence J = 1011010 and K = 0110110 | (5) | [CO2] |
| | (f) | Draw and explain the operation of a 4-bit bidirectional SISO shift register using D flip flops. | (6) | [CO2] |
| | (g) | Distinguish between ripple counter and synchronous counter | (4) | [CO2] |
| | (h) | An IC 555 based astable multivibrator operating at 125 Hz has a charging time of 2.4ms. Find the duty cycle of the circuit. | (3) | [CO2] |

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| 4 | (a) | What are power electronic converters? Write down their names and with the help of block diagrams explain their functions briefly. | (4) | [CO3] |
| | (b) | Describe the different modes of operation using static V-I characteristics of thyristor. What is the effect of gate current on this characteristic. | (5) | [CO3] |
| | (c) | List the different methods of turning off a SCR. Describe any one of them using suitable circuit diagram and associated waveforms. | (5) | [CO3] |
| | (d) | What is meant by GTO? How does a GTO differ from a conventional thyristor? | (4) | [CO3] |

OR

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| 4 | (e) | Draw the R-C firing circuit for SCR and explain with proper waveforms. Why are short pulses preferred over long pulse signals for thyristor triggering? | (5+1) | [CO3] |
| | (f) | Explain with two transistor analogy of an SCR, how positive feedback action takes place during turn-on of an SCR. | (6) | [CO3] |
| | (g) | Why snubber circuits are used in thyristor circuits? Draw the complete protection circuit for a thyristor and explain in detail. | (1+5) | [CO3] |

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| 5 | (a) | Derive an expression for average value of output voltage in a single-phase half-wave-controlled rectifier with resistive load. | (5) | [CO4] |
| | (b) | Discuss the problem of current chopping in phase-controlled rectifiers. How this problem can be overcome using free-wheeling diodes where RL type loads are used? Explain with relevant waveforms. | (8) | [CO4] |
| | (c) | A voltage source $200\sin 314t$ is applied to a thyristor controlled half-wave rectifier with a resistive load of 50Ω . If the firing angle is 30° with respect to supply voltage waveform. Calculate the average power consumed by the load. | (5) | [CO4] |

OR

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| 5 | (d) | Draw the circuit diagram of a single-phase half-wave-controlled rectifier with resistive load. Explain its operation with suitable waveforms for input and output voltages with respect to gate triggering instants of the SCR. | (8) | [CO4] |
| | (e) | How many SCRs are required for a full-wave half-controlled rectifier? Explain its operation with suitable circuit diagram and relevant waveforms. | (6) | [CO4] |
| | (f) | In a 1-phase, half-wave-controlled rectifier feeding a resistive load of 100Ω if the input voltage is 230 V, calculate the average output current for a firing angle of 60° . | (4) | [CO4] |

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|-----------|-----|--|-----|-------|
| 6 | (a) | For a Single-phase AC Voltage Half-Controller feeding a resistive load, derive the expression for RMS value of output current. Draw relevant circuit diagram and waveforms. | (8) | [CO5] |
| | (b) | Explain the operation of a Centre-tapped transformer type Cycloconverter with suitable figures and diagrams. | (5) | [CO5] |
| | (c) | A step-up chopper has an input voltage of 150 V. The voltage output needed is 450 V. The SCR conduction period is 150 μ s. Calculate the chopping frequency. If the pulse width is halved, keeping the chopping frequency same, then how much voltage will be available at output? | (5) | [CO5] |
| OR | | | | |
| 6 | (d) | For a single AC voltage full-controller feeding a resistive load, prove mathematically that it produces symmetrical voltage in positive and negative halves, thereby making the average value equal to zero. | (8) | [CO5] |
| | (e) | With the help of circuit and waveform diagrams, explain the operation of a single-phase half-bridge type voltage source inverter (VSI) with resistive load. | (5) | [CO5] |
| | (f) | With the help of circuit and waveform diagrams, explain the operation of a single-phase half-bridge type voltage source inverter (VSI) with resistive load. | (5) | [CO5] |

----- End of Question paper -----