Ref. No.: Ex/ME(M2)/ES/B/ET/T/113/2025

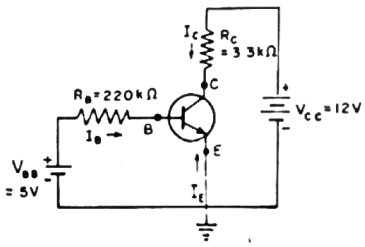
B.E. MECHANICAL ENGINEERING

FIRST YEAR FIRST SEMESTER EXAM 2025

Subject: ELECTRONICS

Time: Three Hours **Full Marks: 100**

Answer Question No. 1 and any FIVE questions from the rest. Q.1 carries 20 marks and the rest are of 16 marks each. Answer in brief with proper justification. All the symbols used carry the standard meanings.

Q. No.		Marks
1.	***Choose the correct option with proper reasons.*** (a) The Fermi level in a pure semiconductor lies i) near the middle of the forbidden gap, ii) in the valence band, iii) in the conduction band. (b) The intrinsic concentration of a semiconductor at $0K$ is i) zero, ii) infinity, iii) $10^{-19}m^{-3}$. (c) The PIV for a half-wave rectifier i) increases, ii) decreases, iii) remains unaltered when a capacitor filter is used. (d) The doping of the emitter region of a transistor is i) greater than, ii) equal to, iii) less than that of the base region. (e) The self-bias arrangement gives a better Q-point stability when i) R_e is small, ii) β is small, but R_e is large, iii) both β and R_e are large. (f) An Op-Amp has i) equal input and output resistances, ii) large input resistance and a low output resistance, iii) a low input resistance and a large output resistance. (g) The Boolean expression $Y = \overline{AB}$ holds for a i) NAND gate, ii) NOR gate, iii) NOT gate ***Fill in the blanks.*** (h) The breakdown region of the volt-ampere characteristic of a p-n junction occurs for _____ bias of the diode. (i) The potential energy of an electron in a p-n junction diode is greater in the _____ side than in the _____ side. (j) An astable multivibrator generates _____ waveform.	$(2 \times 10) = 20$
2.	(a) Differentiate between extrinsic and intrinsic semiconductors? How does doping help in the process? Explain with suitable examples of dopants. (b) Under what circumstances do we call a semiconductor device to be unipolar or bipolar? (c) Write an expression of Current-Voltage characteristics of a p-n junction diode and draw its nature. Represent the current components under different biasing.	(3+2+2) + 2 + (2+5)
3.	(a) Define the stability factors with respect to the changes in I_{CO}, V_{BE} and β. Why is the stability with respect to changes in V_{CE} not considered? (b) Deduce an expression for the dc current gain of a common-base transistor and that of a common-emitter transistor and establish a relation between the two. (c) A silicon $n-p-n$ transistor having $\beta = 100$ and $I_{CO} = 22nA$ is operated in the CE configuration. Assuming $V_{BE} = 0.7V$, determine the transistor currents and the region of operation of the transistor. What happens if the resistance R_C is indefinitely increased? 	6 + 5 + 5
4.	(a) Mention few applications of Astable, Monostable and Bistable multivibrator. (b) Draw the circuit diagram of an astable multivibrator and explain its principle of action, showing the voltage waveforms. Hence calculate the Time period and Duty cycle.	3 + (9 + 4)

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5.	(a) When do we call a logic gate to be "Universal"? Explain with suitable examples. (b) Simplify the Boolean function: $F(A,B,C,D) = \sum(1,3,7,11,15)$ and don't care conditions $d(A,B,C,D) = \sum(0,2,5)$ and hence obtain the SOP and POS forms. (c) Express the Boolean function $F = xy + x'z$ in a product of maxterm form and draw the circuit diagram using logic gates.	3 + (4+2+2) + 5
6.	(a) Simplify $F = xy + x'z + yz$ to minimum number of literals using Boolean Algebra (b) Find the product of two binary numbers 1001.11×100.1 and express the result in decimal form. (c) Convert the following as per the instructions given: i) $(102.56)_{16} \rightarrow (?)_2$ ii) $(13.875)_{10} \rightarrow (?)_8$ iii) $(A5B)_{16} \rightarrow (?)_2$ iv) $(12735.4)_{10} \rightarrow (?)_{16}$	4 + 4 + (2 × 4)
7.	(a) Compare the characteristics of an ideal and practical Operational Amplifier. (b) Show that the closed loop gain of the non-inverting amplifier is the reciprocal of the attenuation of the feedback circuit. (c) With necessary circuit diagrams, mathematical calculations and waveforms, show how can an Op-Amp be used as an i) Adder and ii) Differentiator.	4 + 4 + (4+4)
8.	(a) Draw the circuit diagrams of series and shunt voltage regulators and compare between them. (b) Define the following terms for a rectifier: i) DC load current, ii) ripple factor, iii) conversion efficiency. (c) What is load line in connection with a diode connected to a supply voltage through a series load resistance? How does the load line change with i) the supply voltage, ii) the load resistance, iii) the type of the diode?	(3+3) + 5 + 5
9.	(a) Write down the Schrödinger's equation. Derive the expression of wave function for (i) a particle in an infinite potential well, (ii) a particle in a finite potential well setup. (b) Derive the expression for density of states in a semiconductor crystal. Or Define Fermi-Dirac distribution. Derive the expression for the difference in Fermi level of an intrinsic and an n-type semiconductor.	(2+3+4) + 7