Ref No. Ex/PG/ETCE/T/113D/2025

M. E. ELECTRONICS & TELE-COMMUNICATION ENGINEERING 1ST YEAR 1ST SEMESTER EXAMINATION, 2025

Subject: Microwave & Millimeter Wave Devices & Applications

Time: 3.0 Hours **Full Marks: 100**

No. of questions	Answer any **Four (4)** questions from the followings: 4×25	Marks
1.	a) Proof that for a given device impedance the power capacity of a microwave **BJT** decreases with the increase in the device impedance. b) Give the microwave equivalent circuits of BJT. How the cut-off frequency of BJT is determined? c) How microwave BJT is biased? Explain with suitable circuit diagram. f) A Si microwave transistor has reactance of 2 ohm, transit time cut-off frequency of 2.5 GHz, maximum **E** field 1.42×10^5 V/m and saturation drift velocity of 4×10^5 m/s. Determine the maximum allowable power.	7+(3+3)+5+7
2.	a) Distinguish between MESFET and HEMT. b) Give the physical structure and working principle of HEMT. c) Sketch and explain the output characteristics of HEMT. d) Mention the areas of application of HEMT. e) Give the equivalent circuit of HEMT. f) A HEMT has the following parameters: V_{th} = 0.12 V, $N_d = 2\times10^{24}$ m^{-3}, ψ_{ms} = 0.75 V, E_{gGaAs} = 1.42V, $E_{gAlGaAs}$ = 1.80V and $\varepsilon_{rAlGaAs}$= 4.44. Determine the sensitivity of the HEMT. (Symbols have their usual meanings)	3+(4+4)+3+3+3+5
3.	a) Explain Ridley, Watkinson and Hilsum theory for two valley model of n-type ***GaAs***. b) Why ***Si*** and ***Ge*** are not used to fabricate a Gunn diode? c) i) For a GaAs Gunn diode proof that $$\frac{1}{\sigma}\frac{dJ}{dE} = 1 + \frac{d\sigma/dE}{\sigma/E}$$ (Symbols have their usual meanings) ii) From this expression derive the condition for negative resistance and explain the significance of this condition.	7+4+7+(4+3)

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4.	a) Derive the expression for junction capacitance of a Varactor diode when it is reverse biased. b) Give the doping profile, typical structure and equivalent circuit for this diode. c) Mention the applications of Varactor diode. Explain with suitable circuit diagram how the **Varactor** diode can be used as a parametric amplifier	7+(3+3+4)+(3+5)
5.	a) Give the impurity distribution, space charge density and electric field distribution of a PIN diode. b) What do you meant by conductivity modulation? Why ordinary p-n junction diode does no exhibit this phenomena. c) Give the equivalent circuit of PIN diode under forward and reverse bias condition. d) Derive the expression for impedance of this diode under forward and reverse bias condition. f) How a PIN diode used as a switch? Explain with suitable circuit diagram.	4+(3+2)+(2+2)+7+5
6.	a) Give the cross-sectional view, field distribution and doping profile of a **read diode**. b) Explain how the avalanche multiplication is occurred for this device? c) Derive the expression for input impedance of drift region of this device.	6+7+12
7.	a) Briefly discuss the operation principle of Tunnel diode with suitable energy band diagram. b) i) Give the equivalent circuit of a tunnel diode ii) Derive the expression for resistive cut-frequency and self resonance frequency. c) How a tunnel diode can be used as a negative resistance oscillator? Explain clearly with suitable circuit diagram.	8+(2+8)+7