Code No: 07A6EC06 **R07** **Set No. 2**

III B.Tech II Semester Examinations,APRIL 2011
MICROWAVE ENGINEERING
Common to Electronics And Telematics, Electronics And Communication Engineering

Time: 3 hours Max Marks: 80

Answer any FIVE Questions
All Questions carry equal marks

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1. (a) Explain the need for a reentrant cavity in a Reflex Klystron circuit. Sketch its schematic and obtain an expression for the beam coupling coefficient.
   (b) Account for the 'velocity modulation' process in a 2-Cavity Klystron, and obtain an expression for the modulated velocity and depth of modulation. [8+8]

2. (a) Describe the phenomenon of loop coupling between a coaxial line and a waveguide in detail.
   (b) Write a short notes on the principle of working of a Dielectric Phase Shifter, and mention its applications. [8+8]

3. (a) List out the precautions to be taken for microwave bench measurements.
   (b) With a neat block diagram, explain the method of measurement of Cavity Q by Transmission Method. [8+8]

4. (a) A Travelling Wave Tube amplifier is operated at $V_o = 2400$ V, $I_o = 40$ mA, and $Z_o = 19$ ohms. Find the helix length necessary to give a power gain of 1000 at 6.0 GHz.
   (b) With reference to Magnetron operation, explain and distinguish between the terms Zero Mode, Doublet Modes, pi-mode and N/2 modes of resonance. What are undesired modes of oscillation and how are they objectionable ? [8+8]

5. (a) Explain the nature and basic features of Transferred Electron Devices, citing examples for microwave considerations.
   (b) Describe the physical structure of an IMPATT diode, identifying its doping profile characteristics. [8+8]

6. (a) A Microstrip Transmission line has a dielectric substrate of hight h=0.2 mm., relative permittivity of 4.8, strip width of w=0.26 mm., line thickness 0.03 mm. at 10 GHz. Find its characteristic impedance, listing out the expressions used. What happens if this is assumed as a wide microstrip line ?
   (b) Explain the need for Cavity Resonators at microwave frequencies, identifying their characteristic parameters, merits and limitations. [8+8]

7. (a) Obtain the S-Matrix of a 2-port junction having single shunt susceptance of j 20 milli mhos connected between the two ports having $Z_o = 50$ ohms.

(b) Explain how a lossless, non-reciprocal 3-port junction can be configured as

i. a circulator,

ii. an isolator. [8+8]

8. Given $E_Z = E_o$ Sin (m π X/a) . Sin (n π Y/b) . exp(- j β Z) V/m., list out the Wave Equations involved, and establish the relations for the H field components for TM_{mn} modes in a rectangular waveguide. Explain the meaning of the different symbols involved. Define and explain the significance of the term : cut-off wave number. [16]

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Code No: 07A6EC06 **R07** **Set No. 4**

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Time: 3 hours **Max Marks: 80**

Answer any FIVE Questions
All Questions carry equal marks

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1. (a) A Magnetron operates at V_o = 25 kV, I_o = 25 A, B_o = 0.35 Wb/m^2, the diameters of cathode and anode being 8 cm. and 16 cm. respectively. Find the Cyclotron Angular Frequency, Cut-off Magnetic Field, Cut-off Voltage, and explain the favourable regions for V_o and B_o under which it can oscillate.

   (b) Establish the mathematical relation for power gain in a TWT amplifier, and explain the parameters involved. [8+8]

2. (a) What are 'reentrant cavities' ? Account for their utility and different types, as applicable to microwave tubes.

   (b) A Reflex Klystron resonates at 8.50 GHz, at a repeller voltage = - 250 V, beam voltage = 600 V, in 1 ¾ mode. Find the optimum length required for cavity-repeller spacing. Determine the maximum possible electronic efficiency in this case. [8+8]

3. (a) With neat schematics, explain the physical structure and doping profile of a TRAPATT diode, and sketch its voltage/current versus time characteristics.

   (b) Explain the terms and account for the phenomenon of
      i. Effective Mass,
      ii. Negative Electron Mobility in Ga As compound materials. . [8+8]

4. (a) Explain the significance of a Waveguide Slotted Line, and describe its functional features.

   (b) Account for the different types of errors associated with the measurement of VSWR using a slotted line set up. [8+8]

5. (a) Evaluate the phase and group velocities, Zo for the lowest order TM mode in an air filled circular waveguide of 2.0 cm. diameter at 12 GHz. (Data : X_{01}= 2.405andX'_{11}= 1.841).

   (b) Explain how a rectangular waveguide can be configured as a Cavity Resonator. Hence establish an expression for its dominant mode resonant frequency if its axial dimension is larger than the cross sectional dimensions. [8+8]

6. (a) Describe the principle of working of a waveguide type Rotary Vane Attenuator, with neat schematics.

   (b) Distinguish between the methods of obtaining phase shift using

i. dielectric phase changer, and

ii. rotary vane type phase changer. [8+8]

7. Given $H_Z = H_o$ Cos (m π X/a) . Cos (n π Y/b) . exp(- j β Z) A/m., establish the relations for the E field components of TEmn modes in a rectangular waveguide. Explain the meaning of the different symbols involved. Give its typical sketch in a rectangular coordinate system, and list out the boundary conditions for the tangential E components involved. [16]

8. (a) Define the term Scattering Matrix, and establish the inter-relation between the S and Z matrices.

   (b) Obtain the mathematical expressions at the i/p and o/p and find the angle of rotation, when a linearly polarized TEM wave is allowed to go through a distance of ℓ in a ferrite medium having an axial magnetic field B. [8+8]

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Code No: 07A6EC06 **R07** **Set No. 1**

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Time: 3 hours **Max Marks: 80**

Answer any FIVE Questions
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1. (a) A Ga As Gunn Diode has a device length of 12 microns, threshold field of 2.8 kV/cm., doping concentration of 2.1 x 10^{14} per cm^3 . Find the electron drift velocity, current density and mobility at 9.0 GHz, if the applied field is 3.2 kV/cm. Explain the relations used.
   (b) Sketch the voltage and current waveforms associated with the TRAPATT diode operation, identifying the different regions and their significance. [8+8]
2. (a) Explain the principle of working a H-Plane Tee Junction with neat schematics.
   (b) Explain how a Magic Tee can be used as an Isolator. [8+8]
3. (a) Identify the dominant mode configurations of Rectangular and Circular Waveguides and also Rectangular, Cubical and Circular Cavity Resonators. What are the common types of losses that exist in all these structures? What happens to their performances as the frequency of application increases?
   (b) An air-filled circular guide operates at 9.375 GHz with a guide wavelength of 5.0 cm. Determine its phase constant, group velocity and Z_o . [8+8]
4. (a) List out the necessary mathematical relations in the slottled line method of impedance measurement (no derivations needed) at microwave frequencies, identifying the parameters to be measured and quantities to be calculated.
   (b) With neat schematics, explain the method of measurement of the above parameters in a waveguide bench set up.
   [8+8]
5. (a) List out the differences in performances and applications of Klystrons and TWTs.
   (b) Describe the mechanism of interaction between electrons and fields, and account for the energy delivery and build up of oscillations in a Cylindrical Magnetron, with neat sketches. [8+8]
6. (a) Derive the S-Matrix of a H-Plane Tee Junction, when the side arm port alone is terminated in a matched load. Can all S_{ii} be zero in this component ?
   (b) List out the applications of Ferrite Components, and their requirements. [8+8]
7. (a) Explain the significance of the term O-type in microwave tubes, and account for their typical performance ratings.

(b) A Reflex Klystron operates in $4\frac{3}{4}$ mode with a repeller voltage = - 125 V. Find the repeller voltages for $3\frac{3}{4}$ and $5\ \frac{3}{4}$ modes of operation, assuming same resonant frequency and V_o . Identify the corresponding modes on o/p characteristics graphs. [8+8]

8. (a) Using Poynting Theorem, obtain an expression for the dominant mode power transmitted in a rectangular waveguide, given $E_Y = E_o$ Sin $(\pi\ ^X/_a)$. exp $(-j\ \beta\ Z)$ V/m.

   (b) For a rectangular guide of 2.5 cm x 1.0 cm. cross-section, having $H_Z = 20$ Cos $(\pi\ ^X/_a)$. exp$[j\ (10^{11}\ t + \beta\ Z)]$ A/m., identify the propagating mode and the direction of propagation. Also determine its phase constant and Z_o . [8+8]

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Code No: 07A6EC06 **R07** **Set No. 3**

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Time: 3 hours **Max Marks: 80**

Answer any FIVE Questions
All Questions carry equal marks

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1. (a) With neat schematics, describe the 2-valley model theory, and its applicability for n-type Ga As, specifying the parameter values involved.

   (b) Compare the merits and demerits of TEDs and Avalanche Transit Time Devices. [8+8]

2. (a) The distance between successive minimas has been measured as 2.2 cm in a typical waveguide slotted line measurement, using X-band waveguides of 2.286 cm × 1.016 cm. Find the operating frequency and the guide characteristic impedance for dominant mode operation.

   (b) Describe the utility of a waveguide slotted line in the measurement of VSWR and unknown Impedance. [8+8]

3. (a) List out the microwave applications of TWTs, bringing out their merits and demerits.

   (b) Describe the need and process of Strapping of Magnetrons, distinguishing between single and double ring straps. Sketch the variation of operating wavelength with mode number, in such cases. [8+8]

4. (a) Establish the Scattering Matrix for a Magic Tee Junction. What are S_{ii} in this case ?

   (b) Explain how a 4-port circulator can be realized using Magic Tees and Gyrators. [8+8]

5. (a) List out the Characteristic Equation for phase constant of TE_{np} modes in circular guides, and derive the mathematical expressions for its f_C and guide wavelength.

   (b) Explain and account for the dielectric losses existing in microstrip transmission lines. [8+8]

6. (a) For a 2-Cavity Klystron amplifier, having a gap spacing of 0.9 mm, V_o = 1200 V, spacing between cavities = 4.0 cm., determine the beam coupling coefficients , and the mathematical expression for the modulated velocity at 8.0 GHz. Also calculate its voltage gain and efficiency, if Rsh = 32 kΩ , and I_o = 30 mA.

   (b) Distinguish between the types of cavities employed, voltages used, beam-coupling and grid-interception coefficients, associated with 2-Cavity Klystrons and Reflex Klystrons. [8+8]

7. (a) What is the need for phase shifters at microwave frequencies ? Explain the concept of realizing phase shifting through Dielectric Materials.

   (b) List out the 3 Theorems associated with the 3-port Tee Junctions, and mention their applications. [8+8]

8. (a) Explain how a waveguide can be used as an attenuator, and obtain an expression for the attenuation constant. What should be the cut-off frequency and cut-off wavelength of such an attenuator, for a signal propagating at 15 GHz, if the attenuation is of the order of 208 Nep./m.

   (b) Establish the expressions for the phase and group velocities, and Z_o of TE and TM modes, and sketch their variation with frequency. [8+8]

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