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MICROWAVE ENGINERRING

Paper–ECE–407–E Opt. I

Time allowed : 3 hours]   [Maximum marks : 100

Note : *Attempt any five questions by selecting at least one*

question from each section.

Section–I

1. (a) What is the basic structure of a co-planar waveguide (give diagram), how it works and explain its various types ?   8

    (b) What are the methods of excitation and mechanically tuning a resonator cavity, describe with diagrams ?   8

    (c) Find the resonant frequencies of five lowest modes of an air filled cylindrical cavity of radius 1.905 cm and 2.54 cm. List them in ascending order.   4

2. (a) What are the possible sources of error in the measurement of low VSWR ? 6

    (b) Compare single and double methods of measuring the microwave power. Give advantages and disadvantages of each one of them. 8

    (c) In an SWR measurement at 10GHz the distance between successive minima is 0.1cm. Inside dimensions of waveguide are 4cm and 2cm. TE_{10} mode is propagating through the waveguide. Calculate VSWR. 6

Section–II

3. (a) Why conventional vacuum tubes are less useful signal sources at microwave frequencies above 1 GHz ? Give reasons to support your answers. 8

    (b) Compare the characteristics of 'O' types and 'M' type microwave tubes. 4

(c) What do you mean by Re-entrant cavity and what is their importance at microwave frequencies ? Give its basic structure. 5

(d) If Reflex Klystron operates at $V_0 = 600$ Volts, $L = 1$ mm and $R_{sh} = 15$ KΩ, $f_r = 9$ GHz with $n = 2$ mode of operation then (neglect beam loading and transit time) calculate :

(i) Value of Repeller Voltage.

(ii) Direct current required giving minimum gap voltage of 200 volts.

(iii) Electronic Efficiency. 3

4. (a) Define Plasma and Reduced plasma frequency in context of multi-cavity Klystron and give their significance. 3

(b) By giving importance of Slow wave structures, state Floquet's Periodicity theorem and use it to derive field distribution in slow wave structure of Helix TWT. 10

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(c) A X-band cylindrical magnetron operates under following parametric conditions :

Anode Voltage (V_0) = 26 KV, Beam current (I_0) = 27 A, magnetic flux density (B_0) = 0.336 wb/m^2, Radius of cathode cylinder (a) = 5 cm and radius of vane edge to center (b) = 10 cm then calculate :

(i) Cyclotron Angular Frequency.

(ii) Cut-off Voltage for fixed B_0.

(iii) Cut-off Magnetic Flux density for fixed V_0. 2+2+3=7

Section–III

5. (a) Explain the operation of a Precision Rotary Phase Shifter using suitable diagrams of each of its sectional plates and calculate the value of output electric field if incident electric field E_i is at 45° w.r.t. input plate. 8

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(5)

(b) Prove that a reciprocal network has the same transmission characteristics in either directions. 5

(c) The S-parameters of two port network is given by,

$$S_{11} = 0.2/0^0, \quad S_{22} = 0.1/0^0, \quad S_{12} = 0.6/90^0,$$

$$S_{21} = 0.6/90^0$$

(i) Prove that network is reciprocal but not lossless.

(ii) Find return loss at port 1 when port 2 is short circuited. 2+2=4

(d) How circulator can be constructed using Two Magic Tees, explain with diagram ? 3

6. (a) Calculate the S-parameters of a two port junction terminated by a mismatched load. 8

(b) A three port circulator has an insertion loss of 1dB, isolation 30dB and VSWR is 1.5 Find the S-martrix. 5

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(6)

(c) Explain the operation of H-plane Tee and solve its S-matrix for numerical values of S-parameters when port-3 is perfectly matched. 3+4=7

Section–IV

7. (a) Compare the characteristics of TEDs with microwave transistors. 3

(b) Describe the differential negative resistance phenomenon and using mathematical expressions show that the current density decreases with increasing field E as according to Two Valley model theory. 4+6=10

(c) If applied field in a n-type GaAs Gunn diode having doping concentration 2×10^{14} cm^{-3}, is 3.2 KV/cm at frequency of 10 GHz with diode length of 10μm then, calculate electron mobility and current density. 3

(d) Explain in brief the modes of operation of Gunn Diodes. 4

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8. (a) Compare the performance characteristics of IMPATT and BARITT diodes.   6

(b) Explain principle of operation of TRAPATT diode with suitable diagram.   8

(c) If a M-Si-M diode having doping concentration of 2.8×10^{21} cm^{-3}, silicon length L= 6 µm and $\varepsilon_r = 11.8$, then determine :

   (i) Breakdown Voltage.

   (ii) Breakdown Electric Field.   3+3=6