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No. of Printed Pages—4 **EC-601**

B. TECH.

SIXTH SEMESTER EXAMINATION, 2002-2003

MICROWAVE ENGINEERING

Time : 3 Hours *Total Marks : 100*

Note : (1) Attempt **ALL** the questions.
(2) All questions carry equal marks. Every part of a question is given equal weightage.
(3) Assume suitable data if necessary.

1. Attempt any FOUR parts of the following :— **(5×4=20)**

(*a*) Show that a metal rectangular waveguide is a high pass filter. Derive the formula used.

(*b*) What are Degenerate Modes ? Explain why TEM mode cannot exist in metallic waveguides.

(*c*) Discuss, in brief, the methods of excitation of TE_{10}, TE_{20} and TM_{11} modes in a rectangular metal waveguide.

(*d*) Which mode in circular metal waveguide has got highest cut-off wavelength ? What do the subscripts m and n indicate in TE_{mn} mode of a circular waveguide ? Give two important applications of this waveguide.

(*e*) What is a microstrip line ? How does its characteristic impedance change with change in width to height ratio ? Give a reason for using lower dielectric constant substrate in place of alumina at higher microwave frequencies.

(*f*) A rectangular cavity resonates in the TM_{111} mode at 5·0 GHz. Given a = 8·0 cm and b = 6·0 cm, calculate the resonant frequencies for the TE_{101}, TE_{102} and TE_{111} modes. Assume that the cavity is air-filled.

2. Attempt any FOUR parts of the following :— (5×4=20)

(*a*) (*i*) What do the subscripts of the modes TE_{nml} and TM_{nml} of a rectangular cavity designate ? Write an expression for the resonant frequency of TM_{nml} mode in a rectangular cavity.

(*ii*) Give any one method of exciting TE_{101} mode in an absorption type rectangular cavity.

(*b*) What problems are associated with the simple form of an adjustable short circuit ? How are these problems overcome in variable short circuit ?

(*c*) Give the basic constructional details of a rotary phase shifter and describe, in brief, its principle of operation and working.

(*d*) Compare the practical advantages and disadvantages of the hybrid junction with those of the hybrid ring. Explain the operation of hybrid ring and list its applications.

(*e*) Give the constructional details of a crystal diode and list the requirements that a diode mount must fulfill if this diode is to be used as a detector.

(*f*) Calculate the cut-off frequency of the dominant mode in a 2·5 cm diameter, teflon-filled (E_r = 2·3) circular waveguide. What is its maximum operating frequency if the possibility of higher mode propagation is to be avoided ? Include a 5% safety factor.

3. Attempt any TWO parts of the following :— (10×2=20)

(*a*) Define and interpret (*i*) Directivity and (*ii*) the coupling factor of a directional coupler.

(*b*) Describe the standing wave detector method for measuring the impedance. Derive the formula used. Why is it a common practice to use minima rather than the maxima in measuring distances in connection with the standing wave pattern. List the sources of error in measurement.

(*c*) Distinguish between insertion loss and attenuation. Describe a method to measure insertion loss of a network over a band of microwave frequencies. How can the loss due to reflection at the input port of the network be taken into account in the measurement process ?

4. Attempt any TWO parts of the following :— (10×2=20)

(*a*) What problems are encountered in extending the conventional multi-electrode tubes to microwave frequencies. Describe the principle of operation of reflex klystron oscillator.

(*b*) Draw the schematic diagram of a TWT amplifier and describe its principle of operation. Give the propagation characteristics of different waves generated in the amplifier. Explain how r.f. power output and gain vary with the change in r.f. power input.

(*c*) Draw the schematic diagram of a cylindrical multicavity magnetron and describe its principle of operation.

5. Attempt any TWO parts of the following :— **(10×2=20)**

(*a*) Why are Gunn diodes called Transferred Electron Devices ? Give the mechanism of negative differential resistance in GaAs semiconductor. Describe the behaviour of different modes of operation of a Gunn diode oscillator and give one of its applications.

(*b*) What is the importance of PIN diodes at microwave frequencies. Describe the behaviour of a PIN diode mounted in a transmission line.

(*c*) What is an IMPATT diode ? Draw the schematic diagram and equivalent circuit of the IMPATT diode.