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EC-601

B. TECH.

SIXTH SEMESTER EXAMINATION, 2003-2004

MICROWAVE ENGINEERING

Time : 3 Hours *Total Marks : 100*

Note : (1) Attempt **ALL** the questions.

(2) Assume suitable data, if necessary.

1. Attempt any FOUR parts of the following :—

(*a*) What do subscripts *m* and *n* denote in rectangular and circular waveguides ? Why is TM_{01} mode not possible in rectangular waveguides whereas it does exist in circular waveguides ? **(2.5×2)**

(*b*) When the dominant mode is propagated in an airfilled standard rectangular waveguide, the guide wavelength at a frequency of 9 GHz, is 4 cm. Calculate width of the guide. **(5)**

(*c*) An airfilled rectangular waveguide of cross-section 1 cm × 2 cm is operating in TE_{10} mode at a frequency of 12 GHz. What is the maximum power handling capacity of the guide, if the dielectric strength of the medium is 3×10^6 V/m ? **(5)**

(*d*) Discuss the attenuation characteristics of the circular waveguide. Why does TE_{10} mode show a very low loss at higher frequencies ? **(3+2)**

(*e*) An airfilled circular waveguide having an inner radius of 1 cm, is excited in dominant mode at 10 GHz. Find :

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(*i*) the cut-off frequency of dominant mode,

(*ii*) guide wavelength,

(*iii*) wave impedance, and

(*iv*) bandwidth for operation in dominant mode only. (1.25×4)

(*f*) Give the physical structure and field distribution of a microstrip line. Why can a pure TEM mode not be propagated in a microstrip line ? (2.5×2)

2. Attempt any FOUR parts of the following :—

(*a*) Show that a rectangular cavity may be viewed as a rectangular waveguide shorted at both ends. Also find the resonance condition. (2.5×2)

(*b*) Explain the construction and working of Bethe Hole coupler. Under what conditions does the coupler give maximum directivity ? (3+2)

(*c*) What is Magic Tee ? Why is it called so ? Explain the characteristics of the tee considering various input/output conditions. (1+1+3)

(*d*) What is Hybrid Ring ? Describe the physical structure and operation of a series-connected waveguide hybrid ring. Why is it called rate-race ? (1+1+3)

(*e*) What are the disadvantages of a variable flap attenuator ? How are they overcome in rotary vane attenuator ? (1+4)

(*f*) What is Circulator ? How can a four port circulator be realized using two magic tees and a gyrator ? (1+4)

3. Attempt any TWO parts of the following : —

(*a*) (*i*) How is slotted line used for measurement of impedance of an unknown load ? (5)

(*ii*) A 50 Ω lossless line is terminated in an unknown impedance. The VSWR of the load is 2. When the load is replaced by a short, the minima shifts 1·5 cm towards the load and the successive voltage minima are 5 cm apart. What is the load impedance ? (5)

(*b*) What is Bolometer ? Give the construction of a thermistor mount and explain the method of microwave power measurement using dual bolometer bridge. What is the function of second bridge ? (2+2+4+2)

(*c*) (*i*) What is Wavemeter ? Differentiate between transmission and reaction type wavemeters. Which type is generally used in the microwave test bench in the laboratory ? Explain its construction and working. (2+2+1+3)

(*ii*) State how to measure the frequency of the source without using a wavemeter in the microwave test bench. (2)

4. Answer any TWO parts of the following :—

(*a*) Why is Magnetron also called 'Extended Interaction' tube ? Derive the expression for the Hull cut-off magnetic flux density in a cylindrical magnetron. (3+7)

(*b*) An identical two-cavity Klystron amplifier operates at 4 GHz with $V_0 = 1kV$,

$I_0 = 22\,mA$, cavity gap = 1 mm, drift space = 3 cm and cather cavity total effective shunt conductance $G_{sh} = 0{\cdot}3\times10^{-4}$ mhos. Calculate :

(*i*) Beam coupling coefficient and the input cavity voltage magnitude for maximum output voltage. (5)

(*ii*) Voltage gain and efficiency, neglecting beam loading. (5)

2. (*c*) How is continuous interaction between the electron beam and RF field ensured in a TWT ? Using suitable diagrams, show that the favourable interactions are far more than the unfavourable interactions, resulting in amplification. (4+6)

5. Answer any FOUR parts of the following :—

(*a*) How can PIN diode be used as a microwave switch ? Describe a single PIN switch in shunt and series mounting configurations. (2·5×2)

(*b*) How is plasma trapped in a TRAPATT diode ? Why is the operating frequency of this diode lower than IMPATT ? Give its major merits and demerits. (2+2+1)

(*c*) Discuss the formation and growth of the high field domain in a TED. (5)

(*d*) What are the conditions to be satisfied by the semiconductor in order to exhibit transferred electron effect ? What are the limitations of Ga As diode ? (3+2)

(*e*) Discuss the differences between tunnel diode and ordinary PN junction diode. Show that an amplifier with infinite gain can be built by connecting the tunnel diode to a circulator. (2·5×2)

(*f*) What does acronym IMPATT stand for ? Why does the device show a differential negative resistance ? Give the physical structure, doping profile and electric field distribution of a double drift region IMPATT diode. What is the advantage of double drift region over single drift region ? (1+1+2+1)

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