ENGINEERING & MANAGEMENT EXAMINATIONS, DECEMBER – 2008

RF & MICROWAVE ENGINEERING

SEMESTER – 7

Time : 3 Hours] [Full Marks : 70

GROUP – A

(Multiple Choice Type Questions)

1. Choose the correct alternatives for any *ten* of the following : $10 \times 1 = 10$

i) A hollow waveguide behaves as

a) Low Pass Filter b) Band Pass Filter

c) High Pass Filter d) All Pass Filters. ☐

ii) If the height of the rectangular waveguide is halved, its cut-off wavelength for the dominant mode will

a) be halved

b) remain unchanged

c) be doubled

d) be $\frac{1}{4}$ of its previous value. ☐

iii) The dominant mode of propagation in a circular waveguide is

a) TE_{11} b) TE_{10}

c) TM_{11} d) TM_{10}. ☐

iv) In transmission through a waveguide, the maximum and minimum values of VSWR obtained under loaded conditions are

a) 1 and 0 b) Infinity and zero

c) Infinity and 1 d) – 1 and + 1. ☐

v) A disadvantage of microstrip compared with stripline is that microstrip

a) does not lend itself rapidly to printed circuit technique

b) is more likely to radiate

c) is more complex to manufacture

d) is bulkier. ☐

vi) Microwave components are generally characterized by

a) *h*-parameter b) *z*-parameter

c) *s*-parameter d) *y*-parameter. ☐

vii) A Travelling Wave Tube (TWT) is basically

a) an oscillator b) a tuned amplifier

c) a wideband amplifier d) a transmission line. ☐

viii) *P-I-N* diode is used as

a) a phase shifter b) an amplifier

c) an oscillator d) an isolator. ☐

ix) In a VSWR measurement, a square law detector is used to detect the signal level. The current meter connected to the circuit reads 64 mA and 16 mA as maximum and minimum currents respectively, the VSWR is

a) 4 b) 2

c) 0·25 d) zero. ☐

x) Large mirowave power can be measured by

a) VSWR meter b) Bolometer

c) Calorimeter-wattmeter d) Thermistor. ☐

xi) Caseagrain Feed is used with a parabolic reflector to

a) increase the beam width of the system

b) increase the gain of the system

c) allow the feed to be placed at a convenient point

d) reduce the size of the main reflector. ☐

xii) The uplink and downlink frequencies of satellite communication are

a) 6 GHz, 4 GHz b) 4 GHz, 6 GHz

c) 6 GHz, 6 GHz d) 3 GHz, 5 GHz. ☐

GROUP – B

(Short Answer Type Questions)

Answer any *three* of the following. 3 × 5 = 15

2. An air filled rectangular waveguide of inside dimensions 7·0 cm × 3·5 cm operates in the dominant mode.
   a) Find the cut-off frequency
   b) Determine the guided wavelength at $1{\cdot}5\, f_C$, where f_C is the cut-off frequency.
3. From the properties of a Magic - *T*, derive the *S* - matrix of the ideal magic *T*.
4. Distinguish between the basic principles of working of
   a) a Gunn diode and
   b) an Impatt diode.
5. Derive the Radar Range Equation.
6. Describe the operating principle of a precision type variable attenuator.

GROUP – C

(Long Answer Type Questions)

Answer any *three* questions. 3 × 15 = 45

7. a) Define the term 'Dominant Mode' and explain why wave propagation in a hollow metallic waveguide is preferred in this mode.
   b) Given for propagating TE_{10} mode in a rectangular waveguide ($a \times b$),

   $H_z = A \cos \frac{\pi x}{a} e^{-j\beta z}$ A/m, where symbols have their usual meanings, find the expressions of E_y and H_x. Hence, determine the expression of the wave impedance.
   c) Explain why a pure TEM mode is not supported by hollow rectangular wave guide.
   d) Explain why a rectangular waveguide is preferred over a square waveguide for usual microwave transmission. 4 + 6 + 2 + 3
8. a) Derive an expression for the resonance frequency of a rectangular cavity ($a \times b \times l$), made of a rectangular waveguide with I.D. ($a \times b$) in TE_{101} mode.
   b) Define 'Quality Factor' of a cavity resonator. Discuss the steps involved in finding an expression for '*Q*-factor' of the cavity.
   c) Discuss how such a cavity is excited using a co-axial line. 5 + 2 + 6 + 2 = 15

9. a) Describe an ideal 'Directional coupler'. Define 'Coupling' and 'Directivity' in the context of a directional coupler.

   b) Explain the design of a 2-hole directional coupler in rectangular waveguide version for a given coupling. Mention the principal shortcoming of such a directional coupler. Discuss how this shortcoming can be overcome.

   c) A directional coupler has a coupling factor of 15 dB and directivity of 30 dB. If the power in the coupled port is 32 microwave, find the power in the input port and insertion loss. 5 + 5 + 5

10. a) Explain the working principle of a reflex klystron oscillator.

   b) Explain what is meant by 'velocity modulation' and how this phenomenon is used in the operation of a klystron tube.

   c) Draw the power *vs* repeller voltage and frequency *vs* repeller voltage characteristics of a reflex kystron. Explain qualitatively. 5 + 5 + 5

11. a) Discuss the various means of providing fixed and variable susceptances in rectangular waveguide circuits.

   b) Describe the working principle of a Faraday Rotation Isolator.

   c) In microwave measurements, discuss the role of a slotted line. 6 + 6 + 3

12. Write short notes on any *three* of the following : 3 × 5

   a) Industrial Application of microwaves

   b) Operating Principles of MTI radar

   c) Optimum length and Flare angle of a horn antenna

   d) Structural Characteristics of Microwave Transistors

   e) Tunnel Diode.

END