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## **EC-604**

**B. E. (Sixth Semester) EXAMINATION, June, 2012**

**(Electronics & Communication Engg. Branch)**

**MICROWAVE ENGINEERING**

**(EC - 604)**

*Time : Three Hours*

*Maximum Marks : 100*

*Minimum Pass Marks : 35*

**Note :** Answer all the questions. Assume suitable data if any missing. Answer must be to the point.

1. (a) The locations of two minimums on a slotted line section are found at 4.45 cm and 7.36 cm. What is the incident frequency for a  $TE_{10}$  wave if the cutoff wavelength of the wave guide is 7.0 cm ? 5
- (b) The cutoff wavelength of a waveguide is 1.70 cm and group velocity is  $1.78 \times 10^{10}$  cm/s. What is the incident frequency to the wave guide ? 5
- (c) Determine the inside diameter needed for a circular wave guide to operate in the  $TE_{11}$  mode at a frequency of 12 GHz. 5
- (d) How do TEM and TE wave differ ? 5

*Or*

- (a) How do the dimensions of wave guide affect the cutoff frequency ? 3

**P. T. O.**

- (b) Find the velocity of a wave travelling down a rectangular wave guide whose outer dimensions are  $2.0 \times 1.0$  inch with a wall thickness of  $0.064$  inch and a frequency of operation  $4.4$  GHz. 6
- (c) Discuss how wave equations are useful in understanding the propagation of EM waves in wave guides. 7
- (d) Explain why both incident and reflected waves are required to propagate an electromagnetic wave through a rectangular wave guide. 4
2. (a) A three-way power divider has an insertion loss of  $0.5$  dB. If the input power is  $0$  dBm, what is the output power in dBm and milliwatts at any *one* of the output ports ? 7
- (b) A  $10$  dB directional coupler has a directivity of  $40$  dB. If the input power is  $10$  mW, what are the power outputs at three other ports ? Assume that the coupler is lossless and has an insertion loss of  $0.5$  dB. 8
- (c) How does a flap attenuator differ from a vane type ? 5
- Or*
- (a) What is the significance of using isolator in microwave circuits ? 5
- (b) Explain the characteristics of a 3 port circulator, listing S-matrix. How can this be used as an isolator ? 7
- (c) A  $20$  mW signal is fed into the series arm of a lossless Magic tee junction. Calculate the power delivered through each port when other ports are terminated in matched load. 8
3. (a) Why are transferred electron devices able to operate at higher frequencies than bipolar transistor ? 4

- (b) How does a semiconductor laser differ from a helium-neon gas laser ? 5
- (c) What are the advantages of tunnel diode ? 6
- (d) How does a tunnel diode operate ? 5

*Or*

- (a) Explain negative resistance. 5
  - (b) Explain the operation of Gunn diode. 7
  - (c) Explain the working of Tunnel diode as an oscillator and as an amplifier. 8
4. (a) By means of an Applegate diagram, explain the operation of a reflex klystron. Show that the theoretical efficiency of reflex klystron is 27.78%. 11
- (b) Describe the phenomenon of velocity modulation in a two cavity klystron and explain how microwave power; amplified by the interaction of velocity modulated beam with electromagnetic field in the two cavity klystron. 9

*Or*

An X-band cylindrical magnetron has the following operating parameters : 20

Anode voltage = 26 Kv  
 Beam current = 27 A  
 Magnetic flux density = 0.336 WB/m<sup>2</sup>  
 Radius of cathode cylinder = 5 cm  
 Radius of can edge to centre = 10 cm

Compute :

- (i) the cyclotron angular frequency
- (ii) the cutoff voltage for a fixed magnetic flux density.

Derive all the relations used to calculate the above quantities.

P. T. O.

5. (a) Explain the method to measure VSWR and reflection coefficient. 9
- (b) Explain the operation of calorimetric method of microwave power measurement. 11

*Or*

- (a) Explain a method for the measurement of attenuation at microwave frequencies. 6
- (b) Draw the block diagram of network analyser and explain the function of every block. 14