

- 9.(a) What are the different sections in the block diagram of Vector Network Analyzer (VNA)? Explain the operation of a VNA with a suitable block diagram.
- (b) What do you understand by return loss of a microwave load? How can it be measured using reflectometer?

(1 + 5) + (2 + 4) = 12

**MICROWAVE MEASUREMENT AND INSTRUMENTATION
(ECEN 5234)**

Time Allotted: 3 hrs

Full Marks: 70

Figures out of the right margin indicate full marks.

Candidates are required to answer Group A and Any 5 (five) from Group B to E, taking at least one from each group. Candidates are required to give answer in their own words as far as practicable.

**Group – A
(Multiple Choice Type Questions)**

1. Choose the correct alternative for the following: **10 × 1=10**
- (i) Impedance of a transmission line to the left of voltage minimum is
 (a) inductive (b) capacitive
 (c) high resistance (d) low resistance.
- (ii) The resonant wavelength of the mode TE₁₀₁ of a rectangular cavity
 (a) depends on its both broad and narrow dimensions a and b respectively
 (b) depends on its both broad and length dimensions a and l respectively
 (c) depends only on its broad dimension a
 (d) depends only on its length dimension l.
- (iii) In a slotted line, measurement probes are placed at half power points to measure
 (a) load impedance (b) guided wavelength
 (c) high VSWR (d) low VSWR.
- (iv) A cavity wavemeter measures microwave frequencies because the cavity
 (a) offers high impedance to microwave
 (b) offers resistive load
 (c) has more volume for microwave to interact
 (d) has resonance with one frequency of microwave frequency.
- (v) In general, most of the microwave power-measuring devices actually measure
 (a) instantaneous power (b) peak power
 (c) average power (d) none of these.

- (vi) For measurement of high VSWR, the proper method is
 (a) single-minima method (b) double-minima method
 (c) both (a) and (b) (d) none of these.
- (vii) Large microwave power can be measured with a
 (a) calorimeter (b) thermistor
 (c) barrater (d) thermocouple.
- (viii) The Q factor measures
 (a) frequency selectivity (b) energy stored in the cavity
 (c) energy dissipation (d) all of these.
- (ix) Medium microwave power can be measured using
 (a) calorimeter (b) thermistor
 (c) barrater (d) thermocouple.
- (x) For a critical coupling, the loaded and unloaded Q of a cavity resonator, having an SWR (s) are related by
 (a) $Q_{\text{loaded}} = (s/s+1) Q_{\text{unloaded}}$ (b) $Q_{\text{loaded}} = Q_{\text{unloaded}}/(s+1)$
 (c) $Q_{\text{loaded}} = Q_{\text{unloaded}}/2$ (d) $Q_{\text{loaded}} = Q_{\text{unloaded}}$.

Group - B

- 2.(a) Name the bolometer sensor elements used for microwave power measurement and compare their physical and electrical properties.
- (b) Discuss the conditions of substitutability for the design of bolometer sensors.
6 + 6 = 12
- 3.(a) Discuss the principle of temperature compensated microwave power meter with thermistor power sensor using a self balancing bridge and associated meter logic.
- (b) Discuss the principle of peak power measurement at microwave frequencies.
6 + 6 = 12

Group - C

- 4.(a) Why frequency is more fundamental than wavelength in the microwave spectrum? What are different methods of microwave frequency measurement? Explain any one indirect method of microwave frequency measurement.

- (b) Why is a point contact diode or metal semiconductor or Schottky barrier diode used for detection of microwave power instead of a conventional pn junction diode that is used at lower radio wave frequencies.

(2 + 2 + 2) + 6 = 12

- 5.(a) What are the problems of conventional Standing Wave Detector (SWD) technique for the measurement of high VSWR?
- (b) What is detector loading?
- (c) Discuss briefly the double minima method for measuring a high value of SWR

5 + 2 + 5 = 12**Group - D**

- 6.(a) Justify the statement "For a one port cavity having a Q value less than 10,000 the VSWR technique of Q measurement is used."
- (b) Describe the swept frequency measurement technique for the measurement of cavity Q.

5 + 7 = 12

- 7.(a) Discuss in brief the Von Hippel method of measurement of dielectric constant and loss tangent of a dielectric material at microwave frequency.
- (b) Justify the statement "With the increase of the mismatch factor, the impedance at a voltage maximum increases and the impedance at a voltage minimum decrease". Why is measurement with respect to a voltage minimum more accurate than at a voltage maximum?

6 + (4 + 2) = 12**Group - E**

- 8.(a) What are the similarities and differences between a spectrum analyser and network analyser both in terms of the basic measurements done and from a system engineers point of view.
- (b) "The most common type of spectrum analysers are basically swept tuned super heterodyne receivers"- explain.

6 + 6 = 12