MICROWAVE MEASUREMENT AND INSTRUMENTATION
(ECEN 5242)

Time Allotted : 3 hrs   **Full Marks : 70**

Figures out of the right margin indicate full marks.

Candidates are required to answer Group A and
<u>any 5 (five)</u> from Group B to E, taking <u>at least one</u> 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) A power resistance plot of a device shows a linear increase of resistance with power. The device may be
   (a) a thermistor   (b) a barrater
   (c) a photodiode   (d) an LDR.

   (ii) Medium microwave power can be measured using
   (a) calorimeter   (b) thermistor
   (c) barrater   (d) thermocouple.

   (iii) VNA can measure
   (a) Magnitude of S parameters   (b) Phase of S parameters
   (c) Magnitude and Phase of S parameters   (d) None of (a), (b) & (c).

   (iv) If unloaded Q due to conductor loss and unloaded Q due to dielectric loss is 29390 and 2500 respectively, then the total unloaded Q of the circular cavity is
   (a) 2500   (b) 29390
   (c) 2300   (d) 31890.

   (v) 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.

   (vi) Which of the following is used to measure the high impedance components?
   (a) Parallel connection Q-meter   (b) Series connection Q-meter
   (c) (a) or (b)   (d) (a) and (b) simultaneously.

   (vii) The difference between the spectrum analyser (SA) and CRO is
   (a) CRO and SA both measures time domain signal
   (b) CRO and SA both measures frequency domain signal
   (c) CRO measures time domain signal and SA measures frequency domain
   (d) CRO measures frequency domain signal and SA measures time domain.

(viii) Which of the following is not used in the VSWR measurement?
(a) Reflective Klystron   (b) Slotted line
(c) Frequency meter   (d) Spectrum analyzer.

(ix)   When the port of a network is mismatched, its reflection coefficient is
(a) Still equal to S_{11}
(b) Not equal to S_{11} but independent of Γ_2
(c) Not equal to S_{11} but dependent of Γ_2
(d) None of the above.

(x)   The Q factor measures
(a) frequency selectivity   (b) energy stored in the cavity
(c) energy dissipation   (d) all of (a), (b) & (c).

Group- B

2. (a) What is a bolometer? How it is used to measure an unknown power?
[(CO2)(Analyse/IOCQ)]
    (b) Compare the electrical performance of Barretter and Thermistor. Briefly discuss their mounting techniques.   *[(CO3)(Understand/LOCQ)]*
6 + 6= 12

3. (a) Two identical 30 dB directional coupler are used to sample incident and reflected poer in a waveguide. VSWR = 2 and the output of the coupler sampling incident power is 4.5 mW. What is the value of reflected power?
[(CO4)(Analyze/IOCQ)]
    (b) Explain the self balancing bridge technique for measuring medium power in the range of 10 mW to 10 W.   *[(CO3)(Understand/LOCQ)]*
5 + 7 = 12

Group - C

4. (a) Design an experimental setup to measure impedance of a terminated load in a microwave system.   *[(CO4)(Design/HOCQ)]*
    (b) Double minima method is used to determine VSWR value on a waveguide. If the separation between two adjacent nulls is 3.5 cm and that between twice minimum power points is 2.5 mm, determine the value of VSWR.
[(CO5)(Analyze/IOCQ)]
    (c) What is a VSWR meter? Mention some of its application. *[(CO2)(Understand/LOCQ)]*
5 + 4 + 3 = 12

5. (a) What is a frequency meter? Explain how it is used to measure microwave frequency.   *[(CO3)(Apply/IOCQ)]*
    (b) Describe a suitable frequency measurement technique for the measurement of cavity Q.   *[(CO3)(Understand/LOCQ)]*
6 + 6= 12

Group - D

6. (a) Construct a proper set up to measure unknown dielectric constant.
   [(CO4)(Remember/LOCQ)]

   (b) Define loaded, unloaded and external Q of a cavity resonator. Obtain the relation between the above three quality factors with the help of equivalent circuit of a cavity resonator. *[(CO1)(Analyse/IOCQ)]*

   6 + (3 + 3) = 12

7. (a) Discuss how the null beat technique is used to design microwave frequency counters. *[(CO5)(Analyse/IOCQ)]*

   (b) Calculate the VSWR of a transmission system operating at 10 GHz. Assume TE_{10} wave transmission inside a waveguide of dimensions a = 4 cm, b = 2.5 cm. The distance measured between twice minimum power points is 1 mm on a slotted line. *[(CO5)(Understand/LOCQ)]*

   6 + 6= 12

Group - E

8. (a) Most common type of spectrum analyzers are basically swept tuned super heterodyne receivers-explain. *[(CO2)(Remember/LOCQ)]*

   (b) What are the different sections in the block diagram of VNA? Explain the operation of a VNA with a suitable block diagram. *[(CO2)(Analyze/IOCQ)]*

   6 + 6 = 12

9. (a) What is the basic difference between the scalar and vector network analyser? Construct a test set-up for reflection-transmission measurement.
   [(CO6)(Analyse/IOCQ)]

   (b) A 90W power source is connected to the input of a directional coupler with C = 20dB, D = 35dB, and insertion loss of 0.5dB. Find the output powers at the through, coupled and isolated ports. Assume all ports to be matched.
   [(CO6)(Evaluate/HOCQ)]

   (2 + 4) + 6 = 12

Cognition Level	LOCQ	IOCQ	HOCQ
Percentage distribution	47.91	40.63	11.46

Course Outcome (CO):

After the completion of the course students will be able to
1. Knowledge about the microwave measurement procedures
2. Ability to analyse instruments like spectrum analyzer, Vector Network analyzer etc.
3. Ability to measure microwave power.
4. Idea about techniques to measure power.

5. Capability to analyse problem in measurement procedure and improve.
6. Knowledge about special procedure like TDR

LOCQ: Lower Order Cognitive Question; IOCQ: Intermediate Order Cognitive Question; HOCQ: Higher Order Cognitive Question.