

**MICROWAVE MEASUREMENT AND INSTRUMENTATION
(ECEN 5242)**

Time Allotted : 2½ hrs

Full Marks : 60

Figures out of the right margin indicate full marks.

*Candidates are required to answer Group A and
any 4 (four) from Group B to E, taking one from each group.*

Candidates are required to give answer in their own words as far as practicable.

Group – A

1. Answer any twelve:

12 × 1 = 12

Choose the correct alternative for the following

- (i) 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
- (ii) The sensor used for RF power measurement
 - (a) Thermocouple
 - (b) Microphone
 - (c) Strain gauge
 - (d) Photodiode
- (iii) 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 signal
- (iv) A power resistance plot of a device shows a linear increase of resistance with power. The device may be
 - (a) thermistor
 - (b) a barrater
 - (c) a photodiode
 - (d) an LDR
- (v) When the port of a network is mismatched, its reflection coefficient is
 - (a) Still equal to S11
 - (b) Not equal to S11 but independent of Γ_2
 - (c) Not equal to S11 but dependent of Γ_2
 - (d) None of these

- (vi) Medium microwave power can be measured using
 - (a) calorimeter
 - (b) thermistor
 - (c) barrater
 - (d) thermocouple
- (vii) In general, most of the microwave power measuring devices actually measure
 - (a) instantaneous power
 - (b) peak power
 - (c) average power
 - (d) none of these
- (viii) 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
- (ix) Which of the following equipment is not required for measuring receiver sensitivity and noise measurements?
 - (a) RF signal generator
 - (b) Frequency counter
 - (c) Spectrum analyser
 - (d) Dummy load.
- (x) Without a spectrum analyser, it is not possible to determine
 - (a) pulse width
 - (b) input impedance
 - (c) spurious signal strength and its location
 - (d) carrier frequency.

Fill in the blanks with the correct word

- (xi) The temperature coefficient of _____ is negative.
- (xii) Low VSWR method can be used to measure VSWR up to _____.
- (xiii) _____ method is used to measure high VSWR.
- (xiv) The spurious signal strength and its location is measured by _____.
- (xv) Main application of Time Domain Reflectometer is _____.

Group - B

2. (a) Describe a suitable method to measure a low VSWR produced by a DUT. [[C01](Remember/LOCQ)]
 - (b) What are the advantages in inserting the probe in SWD through a non radiating slot in the waveguide of the SWD? What do you mean by probe loading? [[C02](Analyse/IOCQ)]
- 6 + 6 = 12**

3. (a) Design an experimental setup to measure microwave frequency using frequency meter. [[CO3](Analyse/HOCQ)]
 (b) Describe the swept frequency measurement techniques for the measurement of cavity Q. [[CO4](Remember/LOCQ)]
6 + 6 = 12

Group - C

4. (a) Establish the working formula required to measure Q by VSWR technique. [[CO4](Apply/IOCQ)]
 (b) A 2 port network has the following scattering matrix:

$$\begin{bmatrix} 0.3\angle 0^\circ & 0.7\angle 30^\circ \\ 0.7\angle 30^\circ & 0.3\angle 0^\circ \end{bmatrix}$$

 Evaluate the reflection coefficient seen at port1 when port2 is terminated with a short circuit. [[CO4](Remember/IOCQ)]
6 + 6 = 12
5. (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](Remember/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) Design an experimental setup to measure unknown load impedance. [[CO1](Analyse/HOCQ)]
 (b) What is a reflectometer? How it can be used to measure return loss? [[CO6](Analyse/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](Remember/LOCQ)]
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 $C=20\text{dB}$, $D=35\text{dB}$, 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	43.75	37.5	18.75

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.*