

**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 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) 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.
 - (ii) 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.
 - (iii) 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.
 - (iv) If a TDR trace has a reflected pulse from the cable end of the same polarity as the test pulse, it indicates that the end of the cable is/has _____.
 - (a) Open
 - (b) Shorted
 - (c) Low impedance
 - (d) High crosstalk
 - (v) Which of the following instrument measures the amplitude and phase of the signal?
 - (a) Network analyser
 - (b) Spectrum analyser
 - (c) Oscilloscope
 - (d) Klystron.
 - (vi) A microwave device used in the measurement of VSWR is
 - (a) a crystal
 - (b) a travelling detector
 - (c) a thermocouple
 - (d) none of these.

- (vii) Quality factor-Q of a resonant circuit signifies
(a) Loss in the resonant circuit
(b) Gain in the resonant circuit
(c) Magnetic energy stored in the circuit
(d) Electric energy stored in the circuit.
- (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) For impedance measurement, the following oscillator is used
(a) Reflex klystron tube oscillator
(b) Gunn oscillator
(c) Both
(d) Either reflex klystron or Gunn oscillator.
- (x) 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.

Group - B

2. (a) Describe a suitable method to measure a low VSWR produced by a DUT.
[[CO1](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?
[[CO2](Analyse/IOCQ)]
6 + 6 = 12
3. (a) Explain the basis for classifying microwave power.
[[CO3](Remember/LOCQ)]
- (b) What is a bolometer? How is it used to measure an unknown power?
[[CO3](Analyse/IOCQ)]
- (c) What do you mean by probe loading? Evaluate the effect of probe loading on microwave measurements.
[[CO4](Evaluate/HOCQ)]
2 + 5 + 5 = 12

Group - C

4. (a) Differentiate between absorption type and transmission type wave meter. Mention some application of each wave meter. [[CO3](Remember/LOCQ)]
- (b) Explain the method used to measure attenuation loss and insertion loss of a network.
[[CO3](Analyse/IOCQ)]
5 + 7 = 12

5. (a) Derive the working formula required to measure Q by VSWR technique. [(CO4)(Apply/IOCQ)]
(b) Pulse power in a radar transmitter having peak pulse power of 40 kW with pulse repetition frequency of 250 Hz and pulse width 1 μ s has to be measured with a thermistor power sensor having a CW power rating of 1 MW. Using a 20 dB directional coupler calculate what additional attenuation is required to protect the thermistor from burn out. [(CO3)(Evaluate/HOCQ)]
6 + 6 = 12

Group - D

6. (a) Describe a suitable measurement technique to measure unknown dielectric constant. [(CO4)(Remember/LOCQ)]
(b) Define and state the relationship between loaded, unloaded and external Q of a cavity resonator. [(CO1)(Analyse/IOCQ)]
6 + 6 = 12
7. (a) Discuss how the null beat technique is used to design microwave frequency counters. [(CO5)(Analyse/IOCQ)]
(b) Describe a suitable method to measure a low VSWR produced by a DUT. [(CO5)(Understand/LOCQ)]
6 + 6 = 12

Group - E

8. (a) What are the fundamental differences between a spectrum analyzer and a network analyzer? [(CO2)(Remember/LOCQ)]
(b) Suppose transmitting and receiving antennas are connected to the output and input ports of a network analyzer, respectively, and the complex frequency response is measured over a suitable range of frequencies. What useful information can an antenna designer or wireless engineer derive from this result? [(CO1)(Evaluate/HOCQ)]
(c) What causes systematic errors in the response of a VNA and how can they be removed? [(CO2)(Analyse/IOCQ)]
4 + 4 + 4 = 12
9. (a) What is a reflectometer? Design an experimental setup to realize return loss measurement using reflectometer. [(CO6)(Remember/LOCQ)]
(b) Discuss an experimental setup to identify cable fault using Time Domain Reflector. [(CO6)(Analyse/IOCQ)]
6 + 6 = 12

Cognition Level	LOCQ	IOCQ	HOCQ
Percentage distribution	36.46	47.92	15.62

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