9. (a) What is the purpose of using a pre-selector filter in a spectrum analyser?

   (b) What is the difference between the measurements being done by an oscilloscope and a spectrum analyser?

   (c) Draw and explain the schematic of experimental setup used to measure return loss by Reflectometer.

3 + 3 + 6 = 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) A microwave device used in the measurement of VSWR is
   (a) a crystal (b) a travelling detector
   (c) a thermocouple (d) none of these.

   (ii) The bolometer that has a negative temeperature coefficient of resistivity is called
   (a) barrater (b) varistor
   (c) thermistor (d) calorimeter.

   (iii) Without a spectrum analyser, it is not possible to determine
   (a) pulse width
   (b) input impedance
   (c) spurious signal strength and its spectral location
   (d) all of these.

   (iv) Barraters are used for the measurement of
   (a) VSWR (b) impedance
   (c) power (d) 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) Large microwave power can be measured with a
   (a) calorimeter (b) thermistor
   (c) barrater (d) thermocouple.

(vii) Vector network analyzers can be used to measure
(a) amplitude (b) phase
(c) both amplitude and phase (d) neither of these.

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

(ix) The difference between the spectrum analyzer (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.

(x) The cavity resonator
(a) is equivalent to an LC resonant circuit
(b) in a reflex klystron has its output taken from the reflector plate
(c) produces frequency which is dependent on cavity size
(d) has a low Q factor for narrow band operation.

Group B

2. (a) Explain the principle of measurement of microwave power using a bolometer sensor.

(b) "Bolometer is not capable of measuring high levels of microwave power." With appropriate reasoning justify the above statement.

(c) Discuss the utility of thermocouples in microwave power measurement.

5 + 3 + 4 = 12

3. (a) Discuss the principle of peak power measurement at microwave frequencies.

(b) Compare the electrical performance comparison of barraters and thermistors.

6 + 6 = 12

Group C

4. (a) Derive the scattering matrix of a lossless transmission lines having characteristic impedance Z_0. Prove that the matrix is unitary.

(b) What are the problems of conventional Standing Wave Detector (SWD) technique for the measurement of high VSWR?

7 + 5 = 12

5. (a) Briefly describe the various techniques for the measurement of frequency of a microwave signal.

(b) What is detector loading?

(c) Describe a suitable method to measure low values of SWR produced by a DUT.

5 + 2 + 5 = 12

Group D

6. (a) Describe the swept frequency measurement techniques of unknown dielectric constant.

(b) Define and state the relationship between loaded, unloaded and external Q of a cavity resonator.

6 + 6 = 12

7. (a) Discuss how the null beat technique is used to design microwave frequency counters.

(b) A cavity has a loaded and unloaded Q of 10,000 and 7327, respectively. Calculate the coupling coefficient and external Q. In addition, calculate the loaded Q for
i. an under coupling
ii. a critical coupling and
iii. an over coupling case, if it is required to maintain an SWR of 1.25.

6 + 6 = 12

Group E

8. (a) What is meant by full 2 port calibration of VNA? What is SOLT, RTL and automatic calibration of VNA?

(b) Explain the application of TDR in locating fault in a cable. Sketch time response of TDR for following load conditions
i. $Z_L=2Z_0$
ii. Z_L = Series RL circuit
iii. Z_L = Shunt RC circuit

6 + 6 = 12