M.TECH/ECE/2ND SEM/ECEN 5242/2019
MICROWAVE MEASUREMENT & 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) 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.

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

(iii) The impedance or admittance of a microwave circuit can be determined by measuring
(a) the maximum and minimum values of crystal current
(b) short circuit current
(c) none of these
(d) all of the above.

(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) Main application of TDR is
(a) Location discontinuity (b) Evaluating cable loss
(c) Analyzing reflection (d) All of them.

(viii) In a Smith Chart, the normalized impedance and corresponding normalized admittance are
(a) 0° out of phase (b) 180° out of phase
(c) 90° out of phase (d) 270° out of phase.

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

(x) For a critical coupling, the loaded and unloaded Q of a cavity resonator, having an SWR (s) are related by
(a) $Q_{loaded} = (s/s+1)\, Q_{unloaded}$ (b) $Q_{loaded} = Q_{unloaded}/(s+1)$
(c) $Q_{loaded} = Q_{unloaded}/2$ (d) $Q_{loaded} = Q_{unloaded}$

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) Briefly explain the experimental setup used to measure phase shift of a signal.

5+ 3 + 4 = 12

3. (a) What is an anechoic chamber? Why are large antenna tested in a CATR lab facility in the event of the non availability of open field measurement?

(b) For high Q cavities, normally the case with transmission cavities, transient decay or decrement method is suitable. This method is not suitable for low to medium Q cavities- Justify.

6 + 6 = 12

Group – C

4. (a) What are the primary measurable quantities at microwave frequencies? How are impedance, quality factor and S parameters determined in terms of the primary measurable quantities?

(b) How to measure unknown load impedance using slotted waveguide?

(c) An UHF transmission line of $Z_0 = 75\ \Omega$ is terminated in an unknown load. The VSWR measured in the line is 3 and the position of current minimum nearest to the load is one fifth wavelength away from the load. Calculate the value of impedance.

3 + 4 + 5 = 12

5. (a) What is a reflectometer ? How it can be used to measure return loss?

(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) What do you mean by Quality factor of Cavity Resonator? Explain one method of measuring Quality factor of Cavity resonator.

(b) A cavity has a loaded and un loaded Q of 10,000 and 7327 respectively. Calculate the coupling coefficient and external Q. In addition, calculate the loaded Q for (a) an under coupling (b) a critical coupling and (c) an over coupling case, if we want to maintain an SWR of 1.25.

7 + 5 = 12

7. (a) Discuss in brief the Von Hipple method of measurement of dielectric constant and loss tangent of a dielectric material at microwave frequency.

(b) Discuss how a magic tee can be used to configure the bridge technique of impedance measurement at microwave frequencies.

6 + 6 = 12

Group – E

8. (a) What are the differences between the measurements being done by an oscilloscope and a spectrum analyzer?

(b) Highlight the differences between Network Analyzers and Spectrum Analyzers. In this context, explain the function of a Vector Network Analyzer

4 + 8 =12

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 to identify discontinuity in a transmission line?

6 + 6 = 12

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