M.TECH/ECE/2ND SEM/ECEN 5234/2015
2015

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 x 1=10**

(i) A microwave resonator stores
- (a) electrostatic energy
- (b) magnetostatic energy
- (c) time varying electromagnetic energy
- (d) thermal energy.

(ii) The frequency characteristics is variation of
- (a) frequency with power
- (b) frequency with repeller voltage
- (c) frequency with beam voltage
- (d) frequency with transit time.

(iii) If VSWR is 1.67, VSWR in dB is
- (a) 4.44
- (b) 44.4
- (c) 444
- (d) 2.22.

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

(v) Identify the microwave passive sensor
- (a) Microwave Scatterometer
- (b) Microwave altimeter
- (c) Imaging RADAR
- (d) Microwave Radiometer.

(vi) For mixer circuit operation in spectrum analyzer the IF frequency is 2GHz. If the incoming frequency is 7 GH_z the corresponding image frequency is
- (a) 3 GH_z
- (b) 4 GH_z
- (c) 6 GH_z
- (d) 8 GH_z.

(vii) For a cavity resonator the resonant frequency is 10 GH_z and half power bandwidth is 5 MH_z. Q of the cavity is
- (a) 5000
- (b) 3000
- (c) 2000
- (d) 1000.

(viii) In Smith chart normalized load impedance at voltage maximum is given by
- (a) Γ
- (b) $1+\Gamma$
- (c) $1/S$
- (d) S.

(where Γ and S are reflection coefficient and VSWR respectively).

(ix) In vector network analyzer receiver system employs a
(a) square law detector (b) thermistor
(c) linear detector (d) vector ratio detector.

(x) The input impedance of lossless transmission line becomes repetitive after every line length interval of
(a) λ (b) 2λ (c) $\lambda/2$ (d) $\lambda/4$.

Group – B

2.(a) Describe with schematic diagram the bridge balance technique for measurement of low microwave power. Name different types of sensing elements, mentioning their temperature coefficient of resistance, used in this measurement.

(b) Derive an expression for bridge sensitivity. Explain its significance in achieving high measurement accuracy. What is meant by detector sensitivity? Detector sensitivity depends on what parameters?

(4+1+1)+(3+1+1+1)=12

3.(a) Describe with a neat sketch of experimental set up the method of measurement of high microwave power and also name the method.

(b) What are the sources of errors in high microwave power measurement? Why low power measurement method is not suitable for high power measurement? Mention the ranges of low, medium and high microwave power.

(5+1)+(2+1+3)=12

Group – C

4.(a) Describe the slotted line technique for measurement of frequency in X-band.

(b) In a slotted line set up distance between two successive maxima is measured to be 2 cm. Slotted line is a rectangular waveguide of dimension 0.9"×0.4" operating in TE_{10} mode. What will be the measured frequency of microwave signal?

(c) Elaborate with a neat sketch the principle of operation of absorption wave meter. Describe the procedure for frequency measurement using absorption wavemeter in a microwave measurement set up.

3+3+(4+2)=12

5.(a) Why is the slotted line method for low VSWR measurement not suitable for measurement of high VSWR? Describe the theory for measurement of high VSWR.

(b) What are the sources of errors in the slotted line based measurement of VSWR? How are they eliminated? How is the load impedance calculated from the measured value of VSWR and shift of minimum after replacing a short by load impedance?

(2+4)+(2+1+3)=12

Group – D

6.(a) Describe briefly the theory of construction of Smith chart. What are its applications?

(b) A load impedance of 130+j90 Ω terminates a 50 Ω transmission line that is 0.3 λ long. Find using a Smith chart the reflection coefficient at the load, the input impedance and VSWR on the line. Plot and show the value on the Smith chart.

(5+1)+6=12

7.(a) Define loaded Q, unloaded Q and external Q. What is the relationship between them? Describe with block diagram of experimental set up, the method for slotted line measurement of Q

(b) Explain in detail how experimentally one can measure the dielectric constant of a solid. **(2+1+5)+4=12**

Group – E

8.(a) Describe with a block diagram the principle of operation of Vector Network Analyzer (VNA) elaborating the functions of the constituent circuit blocks inside VNA. Mention the name of some circuits and devices, the performance test of which can be accomplished using VNA.

(b) What are different types of errors that arise in the measurement by VNA? Describe in detail one port calibration technique. How does calibration lead to removal of measurement error?

(4+2)+(2+2+2)=12

9.(a) Name at least four frequency related measurements using Spectrum Analyzer. Draw a block diagram for a Spectrum Analyzer indicating necessary functional sub blocks inside the Spectrum Analyzer. Explain the overall operation of the instrument for any measurement.

(b) With a neat schematic diagram explain the operation of a time domain reflectometer (TDR) and mention some of its industrial applications.

(1+4+1)+(5+1)=12