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DEPARTMENT OF ELECTRONICS & COMMUNICATION ENGINEERING

IV YEAR /VII SEMESTER(REGULATION 2013)

EC6701: RF and Microwave Engineering

Unit – I(TWO PORT RF NETWORKS-CIRCUIT REPRESENTATION)

Part A: Two Mark Questions

1. Name the properties of S-parameters. (Nov/Dec 2012)
2. Draw the equivalent circuit of a practical capacitor. (Nov/Dec 2012)
3. Define reciprocal and symmetrical networks.(May/Jun 2013)
4. Express power input and power output under matched conditions for a two port network in terms of wave components.(May/Jun 2013)
5. Draw the equivalent circuit of an inductor at radio frequency. (Nov/Dec 2013)
6. What is ESR?(Nov/Dec 2013)
7. List any four reasons for the wide use of RF.(May/Jun 2014)
8. Give the relationship between [s] and [z].(May/Jun 2014)
9. What are the high frequency limitations of conventional tubes? (Nov/Dec 2014)
10. Given $[y] = \begin{bmatrix} 3.2 & 1 \\ 1 & 3.2 \end{bmatrix}$ find S parameters. (Nov/Dec 2014)
11. Mention any four differences between low frequency and high frequency microwave circuits.(Apr/May 2015)
12. Draw the high frequency equivalent circuit of the resistor and inductor. (Apr/May 2015)

Part B: Sixteen Mark Questions

1. Formulate scattering matrix for a n-port microwave network. [8] (Nov/Dec 2012)
2. Give the [ABCD] matrix for a network and derive its [S] matrix. (8) (Nov/Dec 2012)
3. The S-parameters of a two port network are given by $S_{11}=0.2\angle 90^o$ $S_{12}=0.5\angle 90^o$ $S_{21}=0.5\angle 0^o$ $S_{22}=0.2\angle 90^o$ (i) Determine whether the network is lossy or not. (8)
   (ii)Is the network symmetrical and reciprocal? Find the insertion loss of network. (8) (Nov/Dec 2012)
4. State and explain the properties of S-parameters. Derive the S-parameters of a

Directional Coupler. (16) (May/Jun 13)

5. Formulate S-matrix for n-port network compute ABCD for a T-network. (16) (May/Jun 13)
6. Write a detailed note on ABCD parameters. (8) (Nov/Dec 2013)
7. The input of an amplifier has a VSWR of 2 and the output has a VSWR of 3. Find the magnitudes of the S-parameters S_{11} and S_{22} under matched condition. (8)(Nov/Dec 2013)
8. A four port network has the scattering matrix shown below.

$$[S] = \begin{bmatrix} 0.1\angle 90° & 0.6\angle -45° & 0.6\angle 45° & 0 \\ 0.6\angle -45° & 0 & 0 & 0.6\angle 45° \\ 0.6\angle +45° & 0 & 0 & 0.6\angle -45° \\ 0 & 0.6\angle 45° & 0.6\angle -45° & 0 \end{bmatrix}$$

(1)Is this network lossless?

(2)Is this network reciprocal?

(3)What is the return loss at port 1 when all other ports are matched? Justify your answer. (10) (Nov/Dec 2013)

9. Find the Z parameters Z_{11} and Z_{22} of the two port T-network shown in figure. (6) (Nov/Dec 2013)
10. With the help of S matrix concept prove the following properties. (i)Symmetry (ii)Unity (iii)Zero and (iv)Phase shift (4x4=16) (May/Jun 14)
11. When do you prefer transmission matrix? Obtain the ABCD matrix of a transformer with turns ratio of N:1.(8) (May/Jun 14)
12. The impedance matrix of a certain lumped element network is given by $[Z] = \begin{bmatrix} 4 & 2 \\ 2 & 4 \end{bmatrix}$. Determine the equivalent scattering parameter matrix $[S_{ij}] = \begin{bmatrix} S_{11} & S_{12} \\ S_{21} & S_{22} \end{bmatrix}$ for the $[Z_{Ij}]$. (8) (May/Jun 14)
13. Discuss the importance of low frequency and high frequency parameters of RF two port networks. (6) (Nov/Dec 14)
14. The two port devices represented by the following matrices are cascaded. Find the scattering matrix of the resulting device. Determine its properties (symmetry, reciprocity, losses and match).

    (1) $\begin{bmatrix} 0.1 & 0.8 \\ 0.8 & 0.1 \end{bmatrix}$ (5)

    (2) $\begin{bmatrix} 0.4 & 0.6 \\ 0.6 & 0.4 \end{bmatrix}$ (5)(Nov/Dec 14)

15. Verify the lossless and reciprocity properties of any two port network using scattering matrix. (16) (Nov/Dec 14)
16. Derive Z and Y matrix formulation of multiport network. (8) (Apr/May 2015)
17. State and prove the symmetry of S matrix for a reciprocal network. (8) (Apr/May 2015)
18. Explain the scattering matrix for lossless junction. (16) (Apr/May 2015)

Unit – II(RFTRANSISTOR AMPLIFIER DESIGN AND MATCHING NETWORKS)

Part A: Two Mark Questions

1. What are the considerations in selecting a matching network? (Nov/Dec 2012)
2. Define power gain of amplifier in terms of S-parameters and reflection coefficients. (Nov/Dec 2012)
3. Why impedance matching is required. What are other constraints required.(May/Jun 2013)
4. Draw typical output stability circle and input stability circle. (May/Jun 2013)
5. Define transducer power gain.(Nov/Dec 2013)
6. Give the expression that relates nodal quality factor (Q_n) with loaded quality factor (Q_L). (Nov/Dec 2013)
7. Define stability. (May/Jun 2014)
8. What are the needs for impedance matching networks? (May/Jun 2014)
9. Define unilateral power gain. (Nov/Dec 2014)
10. State the significance of micro-strip matching networks. (Nov/Dec 2014)
11. Draw the VSWR circle for reflection co-efficient 1. (Apr/May 2015)
12. Draw the contour of Nodal Quality Factor Q=3. (Apr/May 2015)

Part B: Sixteen Mark Questions

1. A microwave amplifier is characterized by its S-parameters. Derive equations for power gain, available gain and transducer gain. (16) (Nov/Dec 2012)
2. What is a matching network? Why is this required? (8) (Nov/Dec 2012)
3. Design a lumped element 'LC' network for matching Z_L=10+j10Ω to a 50Ω transmission line at 1GHz. (8) (Nov/Dec 2012) Use smith chart (16) (May/Jun 2014)
4. Discuss the smith chart approach to design the L-section and T-section matching networks. (16) (May/Jun 2013)
5. Derive the transducer power gain for a transistor amplifier. Design LC network to match source impedance Z_S=(50+j25)Ω to the load Z_L=(25-j50)Ω. Assume Z_O=50Ω,f=2GHz. Use smith chart. (16) (May/Jun 2013)
6. Discuss the design procedure for T and Π matching networks. (Nov/Dec 2013)
7. A MESFET operated at 5.7GHz has the following S-parameters: S_{11}=0.5∟-60°, S_{12}=0.02∟0°, S_{21}=6.5∟115°, S_{22}=0.6∟-35° Verify the circuit, whether it is unconditionally stable or not? (6) (Nov/Dec 2013)
8. Write brief note on:
   (1)Operating power gain (3)
   (2)Available power gain (3)
   (3)Noise figure (4) (Nov/Dec 2013)
9. Derive expressions for the following of a micro strip line matching network. (i)w/h ratio and (ii) Total Q factor (Q_T). (8x2=16) (May/Jun 2014)

10. Explain in detail the concept of T and Micro strip line matching networks. (10) (Nov/Dec 2014)
11. Describe the smith chart. How can it be used to determine unknown impedance? (6) (Nov/Dec 2014)
12. With reference to RF transistor amplifier, discuss the considerations for stability and gain. (8) (Nov/Dec 2014)
13. Show that the noise figure of a three stage amplifier is $F = F_1 + \frac{F_2-1}{GA_1} + \frac{F_3-1}{GA_2}$ where F_1, F_2 and F_3 are noise figures and GA_1 and GA_2 are power gains. (8) (Nov/Dec 2014)
14. Write the mathematical analysis of amplifier stability. (8) (Apr/May 2015)
15. Design a microwave amplifier for maximum transducer power gain. (8)(Apr/May 2015)
16. Using the Smith chart design any two possible configuration of discrete two element matching networks to match the source impedance Z_S=(50+j25)Ω to the load Z_L=(25-j50)Ω. Assume the characteristic impedance of Z_O=50Ω and operating frequency of 2GHz. (16) (Apr/May 2015)

UNIT – III(MICROWAVE PASSIVE COMPONENTS)

Part A: Two Mark Questions

1. A directional coupler is having coupling factor of 20db and directivity of 40db. If the incident power is 100mw. What is the coupled power?(Nov/Dec 2012)
2. Draw the diagram of H-plane Tee junction. (Nov/Dec 2012)
3. Give the significance of Rat-race junctions. (May/Jun 2013)
4. Power at the input is 900mw. If this power is incident on 20dB coupler with directivity 40dB, what is the coupled power and transmitted power. (May/Jun 2013)
5. What are compositions of ferrite? (Nov/Dec 2013)
6. What is gyrator? (Nov/Dec 2013)
7. What are factors that reduce the efficiency of IMPATT diode? (May/Jun 2014)
8. What is negative resistance in Gunn diode? (May/Jun 2014)
9. Mention the application of gyrator and isolator. (Nov/Dec 2014)
10. A 6dB attenuator is specified as having VSWR of 1.2. Assuming that the device is reciprocal, find the S-parameters. (Nov/Dec 2014)
11. Name any two microwave passive device which makes use of faraday rotations. (Apr/May 2015)
12. What are the properties of S matrix? (Apr/May 2015)

Part B: Sixteen Mark Questions

1. Explain the operating principle of microwave circulator with neat diagram.(Nov/Dec 2012)&(Nov/Dec 2014)
2. Explain the properties of H-plane Tee and give reasons why it is called shunt Tee.(Nov/Dec 2012)

3. With neat diagram explain the operation of the following devices
   (i)Gyrator
   (ii)Two hole directional coupler.(Nov/Dec 2012)&(Apr/May 2015)
4. Explain the properties of Magic Tee and derive the scattering matrix for it.(May/Jun 2013)&(May/Jun 2014)
5. Explain the concept of N port scattering matrix representations.(Nov/Dec 2014)&(Apr/May 2015)
6. Discuss the properties scattering matrix. Determine the scattering matrix representations of E plane Tee junctions. (Nov/Dec 2014)
7. Sketch the Energy band structure of Tunnel diode for various biasing voltages.

UNIT – IV(MICROWAVE SEMICONDUCTOR DEVICES)

Part A: Two Mark Questions

1. Name the advantage of parametric devices.(Nov/Dec 2012)
2. State transferred electron effect.(Nov/Dec 2012)
3. Draw the voltage waveforms of a TRAPATT diode.(May/Jun 2013)
4. Write the necessary conditions for Gunn Effect. (May/Jun 2013), (May/Jun 2014)&(Nov/Dec 2014)
5. What are the different types of programmable logic devices? (May/Jun 2013) & (Nov/Dec 2014)
6. What is step recovery diode? (Nov/Dec 2013)
7. Draw the equivalent circuit of varactor diode. (Apr/May 2015)

Part B: Sixteen Mark Questions

1. Explain the working principle of Gunn diode with two valley model plot its characteristics. (Nov/Dec 2013),(May/Jun 2014)&(Apr/May 2015)
2. Draw the physical structure and doping profile of IMPATT diode and explain in detail.(Nov/Dec 2013)&(Apr/May 2015)
3. What are the materials used for MMIC fabrication? Explain the neat diagram the fabrication process of MMIC.(May/Jun 2014)
4. Explain the working principle of parametric amplifier.(Nov/Dec 2014)
5. With a neat diagram explain the construction and characteristic of tunnel diode. Compare tunnel diode and Gunn diode.(Nov/Dec 2014)
6. Define Gunn Effect and explain briefly about Gunn oscillation modes.
7. Draw the construction and explain the working of TRAPATT diode with help of waveforms.

UNIT – V(MICROWAVE TUBES AND MEASUREMENTS)

Part A: Two Mark Questions

1. What are hazards? (May/Jun 2013) & (Nov/Dec 2013)
2. Compare the ASM chart with a conventional flow chart. (May/Jun 2013) & (Apr/May 2015)
3. Define ASM chart. What are the basic building blocks of a Algorithmic state

machine chart? (Nov/Dec 2014)

4. What is synchronous sequential circuit? (Nov/Dec 2013)
5. What is a state diagram? Give an example. (May/Jun 2014)
6. What is critical race condition in asynchronous sequential circuits? Give an example. (Nov/Dec 2014)
7. Differentiate between static and dynamic hazards. (Nov/Dec 2014)
8. List the problems that arise in asynchronous circuits. (Apr/May 2015)
9. What is the most important consideration in making state assignments for asynchronous network? (Apr/May 2015)
10. Distinguish between a combinational logic circuit and a sequential logic circuit. (Apr/May 2015)

Part B: Sixteen Mark Questions

1. Explain the reflex klystron with neat diagram.(Nov/Dec 2012)
2. A two cavity klystron amplifier has the following parameters: Beam voltageV_0=1000v, Beam current I0=25mA, frequency f=3GHz, R0=40kΩ, gap spacing in either cavity d=1mm, spacing between the two cavities L=4cm, effective shunt impedance R_{sh}=30kΩ. Calculate the input gap voltage, voltage gain and efficiency.(Nov/Dec 2012)
3. Explain the bunching process of a two cavity klystron and derive expression for the optimum distance $L_{opt.}$(May/Jun 2013)
4. A pulsed cylindrical magnetron is operated with following parameters: anode voltage=25Kv, Beam current=25A,magnetic density=.35Wb/m^2,radius of cathode cylinder =4cm,radius of anode cylinder=8cm. Calculate a)angular frequency b)The cutoff voltage c)The cut off magnetic flux density.(May/Jun 2013)
5. Derive the equation of velocity modulated wave.(Nov/Dec 2013)
6. Derive the Hull cut-off magnetic and voltage equations.
7. Explain the VSWR measurements with neat sketch.
8. Explain the Wavelength measurement with neat sketch.
9. Explain the operation of two cavity klystron amplifier and compare with travelling wave tube.