

GOVERNMENT COLLEGE OF ENGINEERING

Sethurappatti Village, Fathima Nagar Post, Srirangam Taluk, Tiruchirappalli – 12.
(Affiliated by Anna University, Chennai)

DEPARTMENT OF ELECTRONICS AND COMMUNICATION ENGINEERING



EC 6701 RF AND MICROWAVE ENGINEERING

REGULATION: 2013 (ANNA UNIVERSITY CHENNAI)

SEMESTER: VII

Prepared By

Mr. N. KANAGARAJ M.E.,

ASST. PROF. / ECE / 8128 / MCE

Mr. V. KOUSHICK M.E., P.G.D.VLSI.,

ASST. PROF. (T) / ECE / 8301 / GCE-S

**DEPARTMENT OF ELECTRONICS AND COMMUNICATION
ENGINEERING**

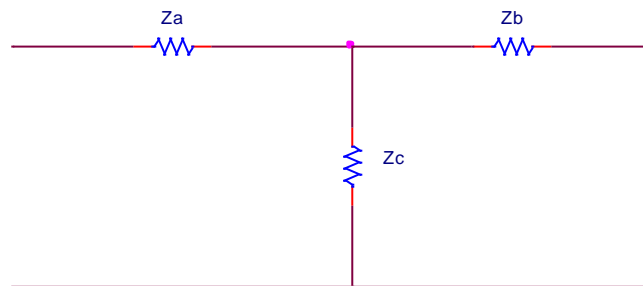
GOVERNMENT COLLEGE OF ENGINEERING

Sethurappatti Village, Fathima Nagar Post, Srirangam Taluk, Tiruchirappalli – 12.
(Affiliated by Anna University, Chennai)

DEPARTMENT OF ELECTRONICS AND COMMUNICATION ENGINEERING UNIT-1

TWO MARKS

1. Write down the S-matrix of an ideal lossless transmission line of length 'l' units. (April'05).
2. Write down the transmission parameters of an ideal lossless transmission line of length 'l' units. (April'05).
3. Write down the ABCD parameters of a lossless transmission line.(DEC'05)
4. State the phase shifting property of S-parameters.(DEC'05)
5. State the properties of S-matrix of a two port lossless, reciprocal, perfectly matched network. (DEC2006).
6. Find the S-matrix of a length l of a lossless transmission line terminated by matched impedance. (DEC2006).
7. What are microwaves? State their applications.(DEC 2007)
8. What are the advantages of [S] matrix over [Z] or [Y] matrices? (DEC 2007).
9. Find the Z parameters of the two port T network shown. (April 2008).

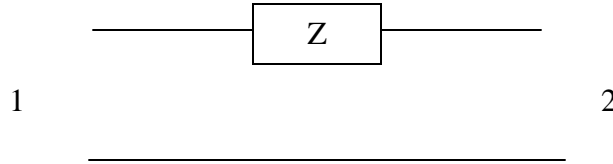


GOVERNMENT COLLEGE OF ENGINEERING

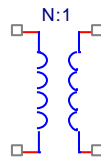
Sethurappatti Village, Fathima Nagar Post, Srirangam Taluk, Tiruchirappalli – 12.
(Affiliated by Anna University, Chennai)

DEPARTMENT OF ELECTRONICS AND COMMUNICATION ENGINEERING

10. Find the S matrix for the series load shown below. Show that $S_{12}=1-S_{11}$ for the series case. (April 2008).



11. What do you mean by symmetry of scattering matrix? (April 2008).
12. Write down the expression for S_{11} in terms of transmission parameters of a two port component. (June 2009)
13. Write down the S matrix for an ideal transformer of turn's ratio 1:10. (June 2009)
14. State the principal advantage of microwave frequencies over lower frequency. (June 2009)
15. Find the ABCD matrix of a transformer with N: 1 turns. (June 2009)



16. List the properties of S-parameters. (Dec 2010) (Dec 2011)
17. What is ABCD matrix? (Dec 2010)
18. Why is it difficult to measure Z, Y, h and ABCD parameters at microwave frequencies? (June 2011)
19. Write the scattering matrix representation of N-port device. (June 2011)
20. Define a reciprocal network. (Dec 2011)
21. For a reciprocal two port microwave component, the magnitude of scattering coefficient S_{11} is 0.091. Find its VSWR. (Dec 2010)

GOVERNMENT COLLEGE OF ENGINEERING

Sethurappatti Village, Fathima Nagar Post, Srirangam Taluk, Tiruchirappalli – 12.
(Affiliated by Anna University, Chennai)

DEPARTMENT OF ELECTRONICS AND COMMUNICATION ENGINEERING

22. Define Scattering parameter. (Dec 2011) (Dec 2016)

23. State the significance of the S matrix representation. (DEC2012).

24. Write the relation between S and ABCD parameters. (DEC2012).

25. A shunt impedance Z is connected across a transmission line with characteristics impedance Z_0 . Find the S matrix of the junction. (June 2013)

26. Differentiate ABCD and S parameters. (June 2013)

27. Draw the equivalent circuit of an inductor at radio frequency. (Dec 2013)

28. What is ESR? (Dec 2013)

29. Define a reciprocal network. (June 2014)

30. The impedance matrix of a microwave circuit is $Z = \begin{bmatrix} 4 & 2 \\ 2 & 4 \end{bmatrix}$. Determine the corresponding S matrix. (June 2014)

31. List out the radio frequency bands available in microwave and radio frequency ranges. (Dec 2016)

GOVERNMENT COLLEGE OF ENGINEERING

Sethurappatti Village, Fathima Nagar Post, Srirangam Taluk, Tiruchirappalli – 12.
(Affiliated by Anna University, Chennai)

DEPARTMENT OF ELECTRONICS AND COMMUNICATION ENGINEERING

UNIT-I 16 Marks

1. State and prove the properties of scattering matrix. (April'05) (June 2009))
(June 2011) (DEC 2011) (June 2013)
2. Obtain the relationship of S-parameters in terms of ABCD parameters. (8) (DEC'05)
(DEC 2011).
3. Find the S parameters of an ideal transformer of turn's ratio 1:n. (8) (DEC'05).
4. Explain why z or y or ABCD parameters are not preferred in microwave circuit analysis,
but S-parameters are used. (8) (DEC2006).
5. With the help of a 3 port network, establish relationship between S and Z matrices. (8)
(DEC2006).
6. A Two port network is terminated by mismatch generator and load. Derive an
expression of input reflection coefficient Γ_1 in terms of load reflection coefficient Γ_2 and
S- parameters of the network when it is lossless and reciprocal. (8)(DEC2006).
7. The S-parameters of a two port network are $S_{11}=0.2\angle 0^\circ$, $S_{22}=0.1\angle 0^\circ$, $S_{12}=0.6\angle 90^\circ$,
 $S_{21}=0.6\angle 90^\circ$. Prove that the network is reciprocal but not lossless. If Γ_2 for a short
circuit, find Γ_1 and return loss in dB. (8)(DEC2006).
8. Describe the need for scattering matrix formulation and obtain the S-matrix of a 'n' port
network. (10)(DEC 2007).
9. Explain the phase shifting property and prove that $S'_{nn}=e^{-2j\theta_n} S_{nn}$. (6) (DEC 2007).
10. Prove that symmetry of impedance matrix and hence prove that the S matrix is also
symmetrical for reciprocal junction. (16) (DEC 2007).
11. Prove the reciprocal and lossless properties of the S matrix.(16)(April 2008)
12. Prove the reciprocal and lossless properties of the Z matrix.(16)(April 2008)

GOVERNMENT COLLEGE OF ENGINEERING

Sethurappatti Village, Fathima Nagar Post, Srirangam Taluk, Tiruchirappalli – 12.
(Affiliated by Anna University, Chennai)

DEPARTMENT OF ELECTRONICS AND COMMUNICATION ENGINEERING

13. What is scattering matrix? Derive scattering matrix formulation for n-port network.(8)(April 2008)
14. Prove is impossible that it is impossible to construct a perfectly matched, lossless, reciprocal three port junction.(8)(DEC 2008) (DEC 2009)
15. State and prove 'PHASE SHIFTING' property of S matrix. (6) (June 2009)
16. For a lossless 50Ω line, $\beta_1 = 1.95$ radians. Determine the ABCD parameters. What is the input impedance if the line is terminated with a load impedance of 100Ω ? (10) (June 09)
17. From the first principle, derive the ABCD parameters of a general transmission line. (6) (June 2009)
18. State and prove UNITARY PROPERTY (Unity and Zero property) of S matrix. (10) (June 2009)
19. What do you mean by S parameters? Why do we require S parameters?(8)(April 2010)
20. Derive relation between Z, Y, and ABCD Parameters with S-parameters (6) (DEC 2010) (June 2013) (June 2014)
21. Derive the expression for the Scattering matrix of multiport network. (10)(DEC 2010).
22. Two transmission lines of characteristic impedance Z_1 and Z_2 are joined at plane pp'. Express S-parameters in terms of impedances.
23. Derive the expression for the S-parameters of a Two-port network with mismatched load. (16)(June 2011) (June 2014)
24. What are the advantages of S parameters in terms of ABCD parameters (4) (DEC 2011).
25. Draw an N-port network and derive the S-matrix. (8)(DEC2011).

GOVERNMENT COLLEGE OF ENGINEERING

Sethurappatti Village, Fathima Nagar Post, Srirangam Taluk, Tiruchirappalli – 12.
(Affiliated by Anna University, Chennai)

DEPARTMENT OF ELECTRONICS AND COMMUNICATION ENGINEERING

26. Discuss the properties of S matrix. The S matrix of a two port device is

$$\begin{bmatrix} 1 & 0.7 \\ 0.7 & 1 \end{bmatrix}$$

The incident power to port 1 is $P_1 = 50\text{mW}$ and $P_2 = 0\text{mw}$.

- Calculate a_1 and a_2 .
- Using the S matrix find b_1 and b_2 .
- Determine the reflected power at each of the port. (8)(DEC2012).

27. Given $Y = \begin{bmatrix} 3.2 & 1 \\ 1 & 3.2 \end{bmatrix}$ find [S]. (8)(DEC2012).

28. Find the S matrix of a section of a transmission line whose characteristics impedance is Z_0 and propagation constant β . Find Z matrix. (8)(DEC2012).

29. Show using S matrix theory that a lossless non-reciprocal two port microwave device cannot be constructed. (8) (June 2013)

30. Compare S, Z and Y matrices. (6) (June 2014)

31. The S matrix of a two port microwave network is given below. (16) (June 2014)

$$S = \begin{bmatrix} 0.1\angle 0^\circ & 0.9\angle -45^\circ \\ 0.9\angle 45^\circ & 0.3\angle 0^\circ \end{bmatrix}$$

Find out

- If the network is lossless.
- If the network is reciprocal.
- The return loss if the port z is terminated in a matched load; and
- The return loss if the port z is terminated in a short circuit.

32. Write a detail note on ABCD parameter. (8)(Dec 2013)

GOVERNMENT COLLEGE OF ENGINEERING

Sethurappatti Village, Fathima Nagar Post, Srirangam Taluk, Tiruchirappalli – 12.
(Affiliated by Anna University, Chennai)

DEPARTMENT OF ELECTRONICS AND COMMUNICATION ENGINEERING

33. A four port network has the S matrix shown below: (Dec 2013)

$$\begin{bmatrix} 0.1 \angle 90^\circ & 0.6 \angle -45^\circ & 0.6 \angle 45^\circ & 0 \\ 0.6 \angle -45^\circ & 0 & 0 & 0.6 \angle 45^\circ \\ 0.6 \angle 45^\circ & 0 & 0 & 0.6 \angle -45^\circ \\ 0 & 0.6 \angle 45^\circ & 0.6 \angle -45^\circ & 0 \end{bmatrix}$$

- Is this network lossless?
- Is this network reciprocal?
- What is the return loss of port 1 when all other ports are matched?

Justify your answer.

34. What is T matrix? Obtain and explain the relationship with [S] and vice versa. (8) (Dec 2016)

35. Compute the intrinsic wave impedance, phase velocity and wavelengths of an electromagnetic wave in free space and a PCB material whose dielectric constant is 4.6 for 30MHz and 3 GHz. (8) (Dec 2016)

36. Explain and analyze any reciprocal lossless network with derivation. (10) (Dec 2016)

37. Discuss on the application of RF and microwave area. (6) (Dec 2016)

GOVERNMENT COLLEGE OF ENGINEERING

Sethurappatti Village, Fathima Nagar Post, Srirangam Taluk, Tiruchirappalli – 12.
(Affiliated by Anna University, Chennai)

DEPARTMENT OF ELECTRONICS AND COMMUNICATION ENGINEERING UNIT-2

1. Define transducer power gain. (Dec 2013)
2. Give the expression that relates nodal quality factor (Q_n) with loaded quality factor (Q_L).
(Dec 2013)
3. What is the need of impedance matching?
4. What is double stub matching?
5. What is the need of multi section quarter wave transformer?
6. Define strip line
7. What is Microstrip line?
8. What is figure of merit?
9. Define noise figure. (Dec 2016)
10. Calculate VSWR of an amplifier, if the amplifier has reflection coefficient 0.2533. (Dec 2016)

GOVERNMENT COLLEGE OF ENGINEERING

Sethurappatti Village, Fathima Nagar Post, Srirangam Taluk, Tiruchirappalli – 12.
(Affiliated by Anna University, Chennai)

DEPARTMENT OF ELECTRONICS AND COMMUNICATION ENGINEERING UNIT-II 16 Marks

1. A MESFET operated at 5.7GHz has the following S parameters:

$$S_{11} = 0.5 \angle -60^\circ, S_{12} = 0.02 \angle 0^\circ, S_{21} = 6.5 \angle 115^\circ, S_{22} = 0.6 \angle -35^\circ.$$

Verify the circuit whether it is unconditionally stable or not? (6) (Dec 2013)

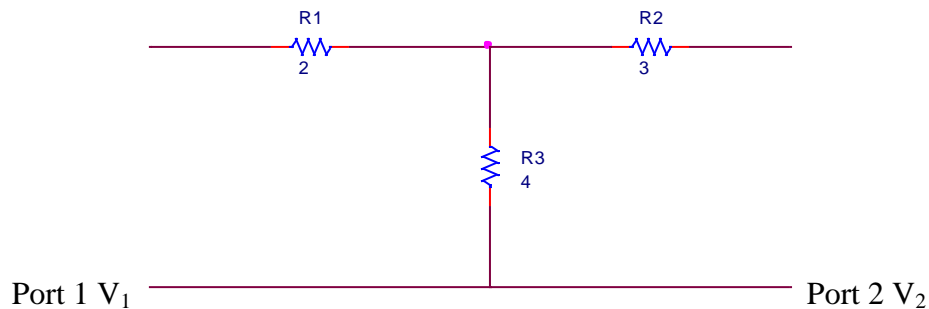
2. Write brief notes on: (Dec 2013)

- Operating power gain (3)
- Available power gain (3)
- Noise figure (4)

3. Discuss the design procedure for T and π matching networks. (Dec 2013)

4. The input of an amplifier has a VSWR of 2 and the output has a VSWR of 3. Find the magnitudes of the S parameter S_{11} and S_{22} under matched condition. (8) (Dec 2013)

5. Find the Z parameters Z_{11} and Z_{22} of the two port network shown below. (Dec 2013)



6. Derive the equation for power gain, available power gain, transducer power gain. (16)
(Dec 2016)

7. Investigate the stability region of a transistor whose S parameters are recorded as follows: $S_{12} = 0.2 \angle -10^\circ$, $S_{11} = 0.7 \angle -70^\circ$, $S_{21} = 5.5 \angle 85^\circ$, $S_{22} = 0.7 \angle -45^\circ$ at 750MHz
(16) (Dec 2016)

GOVERNMENT COLLEGE OF ENGINEERING

Sethurappatti Village, Fathima Nagar Post, Srirangam Taluk, Tiruchirappalli – 12.
(Affiliated by Anna University, Chennai)

DEPARTMENT OF ELECTRONICS AND COMMUNICATION ENGINEERING **UNIT – 3**

1. Find the magnitude of the scattering parameters for a reciprocal two-port microwave component having the VSWR as 1.4 and the insertion loss as 1 dB. [Apr/May'05]
2. State the TWO PARAMETERS that describe a directional coupler. Define them. [Nov/Dec'05]
3. Calculate the attenuation of a rotary vane attenuator if the angle of rotation is 34° . [Nov/Dec'05]
4. What impedances are offered by a tuning screw on the broad wall of rectangular, waveguide when depth of penetration varies? [Nov/Dec'06]
5. Give the constructional details of a matched termination. [Nov/Dec'07]
6. What are the waveguide corners, bends and twists? [Nov/Dec'07]
7. Mention for what purpose the ports and screws are used in a waveguide. [Apr/May'08]
8. Define Directivity of a Directional coupler. [Apr/May'08]
9. What is the difference in scattering matrix representation of E plane tee and H plane tee? [May/Jun'09]
10. If the VSWR= 1 at the input port of a microwave component, what is S_{11} ? [May/Jun'09]
11. What are the types of directional couplers? [Nov/Dec'09]
12. List the application of waveguide twist. [Nov/Dec'09]
13. State the primary functions of a microwave isolator. [Apr/May'10]
14. A cavity resonator having dimensions $a = 2\text{cm}$, $b = 1\text{cm}$ excited by TE_{101} mode at 20GHz. Calculate length of cavity. [Apr/May'10]
15. Write the s – matrix for directional coupler. [Nov/Dec'10]

GOVERNMENT COLLEGE OF ENGINEERING

Sethurappatti Village, Fathima Nagar Post, Srirangam Taluk, Tiruchirappalli – 12.
(Affiliated by Anna University, Chennai)

DEPARTMENT OF ELECTRONICS AND COMMUNICATION ENGINEERING

16. State the principle of microwave phase shifter. [May/June'11]

17. What is the purpose of isolator in a microwave test bench? [May/June'11]

18. What should be the minimum radius of curvature for E plane bend and H plane bend?

Validate your answer. [Nov/Dec'11]

19. State the two parameters that describe a directional coupler and define them.

[Nov/Dec'11]

20. Define Faraday rotation. [Nov/dec'11] [Nov/Dec'08]

21. What are the applications of hybrid couplers? [Nov/Dec'11]

22. Mention the applications of circulator. [Nov/Dec'12]

23. List the ideal characteristics of matched load. [Nov/Dec'12]

24. What are the compositions of ferrite? [Nov/Dec'13]

25. What is gyrator? [Nov/Dec'13]

26. How does an isolator differ from an attenuator? [May/June'13]

27. Mention the applications of E plane and H plane tee. [May/June'13]

28. Using the s – matrix of an E or H plane tee, outline its basic properties. [May/June'14]

29. What is Faraday rotation? How does it originate and what are its uses in various device?

[May/June'14]

30. Compare PIN and PN diode. (Dec 2016)

31. What is isolator? And why it is called as uniline? (Dec 2016)

GOVERNMENT COLLEGE OF ENGINEERING

Sethurappatti Village, Fathima Nagar Post, Srirangam Taluk, Tiruchirappalli – 12.
(Affiliated by Anna University, Chennai)

DEPARTMENT OF ELECTRONICS AND COMMUNICATION ENGINEERING UNIT – 3 16 MARKS

1. Find the scattering matrix of an ideal, symmetrical, lossless magic T junction. (16)
[Apr/May'05]
2. From the first principle, derive the scattering matrix of an ideal directional coupler. Hence or otherwise write down [s] matrix of HYBRID COUPLER and MAGIC-T. (12)
[Nov/Dec'05]
3. What is the value of DIRECTIVITY of an ideal DIRECTIONAL COUPLER? Why? (4)
[Nov/Dec'05]
4. Design a three-hole Chebyshev directional coupler using centre apertures in the common broad wall between two rectangular w/g of dimensions $0.9'' * 0.4''$ to be operated at 9 GHz. Find the distance between the holes. (16) [Nov/Dec'06]
5. A three port circulator has an insertion loss of 1dB, an isolation of 20dB, and VSWR of 1.2 when all ports are matched terminated. Find the S matrix of the junction and the output power at port 2 and 3 for an input power of 100 mW at port 1. (16) [Nov/Dec'06]
6. What is the function of an isolator? Write down its 'S' parameters. (6) [Nov/Dec'07]
7. From the first principles derive the scattering matrix of a circulator. (10) [Nov/Dec'07]
8. What are the waveguide Tees? Where are they used? (4) [Nov/Dec'07]
9. Derive the Scattering matrix for E-plane Tee and H-plane Tee. (12) [Nov/Dec'07]
10. Derive the S – matrix for E – plane tee. (8) [Nov/Dec'09]
11. A three-port circulator has an insertion loss of 1 dB, isolation 30 dB and VSWR= 1.5. Find the S-matrix. (8) [Apr/May'08] [May/Jun'13]
12. Verify the branch line couplers have a phase – shift of 90° and a power level of 3db using even and odd symmetry. (16) [Apr/May'08]

GOVERNMENT COLLEGE OF ENGINEERING

Sethurappatti Village, Fathima Nagar Post, Srirangam Taluk, Tiruchirappalli – 12.
(Affiliated by Anna University, Chennai)

DEPARTMENT OF ELECTRONICS AND COMMUNICATION ENGINEERING

13. What is the function of an isolator? Write down its 'S' parameters. (4) [Apr/May'08]

14. Explain the working of a circulator and hence obtain the scattering matrix of the circulator from the first principle. (12) [Apr/May'08] [Dec 2016]

15. List out the characteristics of the Magic -T when all the ports are terminated with matched load. (8) [Nov/Dec'08]

16. How can you synthesize a rat- race hybrid coupler from magic-tee? (8) [Nov/Dec'08]

17. The specification of a three port circulator are given as insertion loss = 1.1 dB, isolation=20dB and VSWR = 1.5. Characterize the circulator by its S parameters. (8) [May/Jun'09]

18. From the first principle, derive the S matrix of a magic Tee. (8) [May/Jun'09]

19. A 5 dB waveguide attenuator is specified as having a VSWR of 1.2. Assuming that it is reciprocal, find its S-parameters. (6) [May/Jun'09]

20. From the first principles derive the scattering matrix of a magic - T. (10) [May/Jun'09]

21. Prove that it is impossible to construct a perfectly matched, lossless, reciprocal three port junction. (8) [Nov/Dec'09] [Apr/May'08] [Nov/Dec'08]

22. List the characteristics of hybrid tee when all the ports are terminated with matched load. (8) [Nov/Dec'09]

23. Discuss briefly on Faraday rotation isolator. (8) [Nov/Dec'09] [Nov/Dec'11]

24. What do you mean by S parameters? Why do we require S parameters? Draw the diagram of a directional coupler and explain its working. Derive S matrix of a directional coupler. (16) [Apr/May'10]

25. Explain the principle of operation of the following devices and obtain their S matrix. [Nov/Dec'10]

GOVERNMENT COLLEGE OF ENGINEERING

Sethurappatti Village, Fathima Nagar Post, Srirangam Taluk, Tiruchirappalli – 12.
(Affiliated by Anna University, Chennai)

DEPARTMENT OF ELECTRONICS AND COMMUNICATION ENGINEERING

✓ Waveguide H Plane Tee (5)

✓ Waveguide E Plane Tee (5)

✓ Magic Tee (6)

26. Discuss the constructional features and principle of operation of the following.

[Nov/Dec'10] [May/June'11]

✓ Bends, corners and twists (6)

✓ Coupling loops. (6)

✓ Phase shifters. (4)

27. Explain any two applications of magic tee with necessary diagrams. (8) [May/June'11]

28. Derive the S matrix of a three port circulator. (8) [May/June'11] [Nov/Dec'08]

29. Explain the principle of attenuators and phase shifters. (12) [Nov/dec'11]

30. Find the attenuation in decibels for an ideal rotary vane attenuator for vane rotation of $\theta = 0^\circ$ and 60° . (4) [Nov/Dec'11]

31. Explain the mechanism of Bethe hole directional coupler with neat diagram. (10)
[Nov/Dec'11]

32. Derive the s matrix of magic tee and also explain the working principle of magic tee with neat diagrams. (10) [Nov/dec'11] [Nov/Dec'12]

33. Explain the two hole directional coupler with diagrams derive the scattering matrix for the same. (16) [Nov/dec'11]

34. What is need for passive components and devices? Explain structure and function of waveguide choke flanges and coupling loops. (16) [Nov/Dec'12]

35. Describe the following with neat sketch. [Nov/Dec'13]

✓ Magic tee (8)

GOVERNMENT COLLEGE OF ENGINEERING

Sethurappatti Village, Fathima Nagar Post, Srirangam Taluk, Tiruchirappalli – 12.
(Affiliated by Anna University, Chennai)

DEPARTMENT OF ELECTRONICS AND COMMUNICATION ENGINEERING

- ✓ Directional coupler (8)

36. Explain the operation of following microwave devices. [Nov/Dec'13]

- ✓ Circulator (8)

- ✓ Isolator (8)

37. Discuss the structure, working principle and application of the following microwave devices. (16) [May/Jun'13] [May/Jun'14]

- ✓ Phase shifters

- ✓ Short circuit plunger

- ✓ Tuning screws.

- ✓ E Plane and H plane tees.

38. What is magic tee? A magic tee is terminated at collinear ports 1 and 2 and different port 4 by impedance of reflection coefficients $\Gamma_1 = 0.5$, $\Gamma_2 = 0.6$ and $\Gamma_4 = 0.8$ respectively. if 1W power is fed at the sum port 3, calculate the power reflected at the port 3 and power transmitted to the other three ports. (16) [May/Jun'13]

GOVERNMENT COLLEGE OF ENGINEERING

Sethurappatti Village, Fathima Nagar Post, Srirangam Taluk, Tiruchirappalli – 12.
(Affiliated by Anna University, Chennai)

DEPARTMENT OF ELECTRONICS AND COMMUNICATION ENGINEERING **UNIT – 4**

1. Give any two differences between microwave transistors and transferred electron devices.
[Apr/May'05]
2. Which two phase angles make the voltage and current in Avalanche transit time devices to be out of phase by 180° ? [Nov/Dec'05]
3. What are the differences between Transferred Electron Devices and Avalanche Transit-time Devices? (NOV/DEC 2006) [Apr/May'08]
4. What are the advantages and disadvantages of parametric amplifiers? [Nov/Dec'06]
5. List the advantages of Microwave IC's. [Apr/May'08] [Nov/Dec'08] [May/Jun'09]
6. Name the different types of lithography. [Apr/May'08]
7. Define transferred electron effect. [Nov/Dec'08]
8. What are major disadvantages of IMPATT diodes? [Nov/Dec'08]
9. What do the acronyms IMPATT, TRAPATT and BARITT stand for? [May/Jun'09]
10. List out the high frequency limitations of bipolar devices. [Nov/Dec'09]
11. Give the major disadvantages of IMPATT diodes. [Nov/Dec'09]
12. Distinguish between hybrid and monolithic MICs. [Nov/Dec'09]
13. Mention any two applications of parametric amplifier. [Apr/May'10]
14. What do you understand by Monolithic Microwave Integrated Circuits? [Apr/May'10]
15. Compare GUNN diode with IMPATT diode. [Nov/Dec'10] [May/Jun'13]
16. What are the different modes of operation of GUNN diode? [May/June'11]
[Nov/Dec'11]
17. List out the limitations of parametric amplifiers. [May/June'11]

GOVERNMENT COLLEGE OF ENGINEERING

Sethurappatti Village, Fathima Nagar Post, Srirangam Taluk, Tiruchirappalli – 12.
(Affiliated by Anna University, Chennai)

DEPARTMENT OF ELECTRONICS AND COMMUNICATION ENGINEERING

18. What is necessary condition for an IMPATT diode to produce oscillations? [Nov/Dec'11]
19. Define Gunn Effect. [Nov/Dec'11] [May/Jun'09] [Nov/Dec'07] [Apr/May'08]
20. What are the properties of parametric up converter? [Nov/Dec'11]
21. Draw the Gunn diode characteristics. [Nov/Dec'12]
22. What are the uses of parametric amplifier? [Nov/Dec'12]
23. What is a step recovery diode? [Nov/Dec'13]
24. Mention the ideal characteristics of dielectric material in MMIC. [Nov/Dec'13]
25. Draw the V – I characteristics of varactor diode. [May/Jun'13]
26. State the differences between a low frequency transistor and a microwave transistor.
[May/Jun'14]

GOVERNMENT COLLEGE OF ENGINEERING

Sethurappatti Village, Fathima Nagar Post, Srirangam Taluk, Tiruchirappalli – 12.
(Affiliated by Anna University, Chennai)

DEPARTMENT OF ELECTRONICS AND COMMUNICATION ENGINEERING **UNIT – 4 16 MARKS**

1. Hence or otherwise show how negative resistance characteristics is obtained in a Gunn diode. (8) [Apr/May'05]
2. Write in detail the principle mechanism of operation and the application of IMPATT diode. (16) [Nov/Dec'05]
3. Explain using multivalley energy diagram, the I-V characteristics of Gunn diodes. Draw and explain electrical equivalent circuit. Explain LSA mode of operation. (8) [Nov/Dec'06]
4. A GaAs Gunn diode oscillator operates at 10 GHz with drift velocity of electrons 10^5 m/s. Determine the effective length of the active region. What is the required dc voltage for oscillation? Critical field is $3 \mu\text{v/cm}$. (8) [Nov/Dec'06]
5. Explain the I-V characteristics of Tunnel diode and its electrical equivalent circuit. Obtain an expression of resonant frequency. With the help of a diagram explain operation and obtain power gain expression for a reflection amplifier. What are the advantages of tunnel diode?(16) [Nov/Dec'06]
6. What is Gunn diode? Explain the working of Gunn diode as an oscillator. (8) [Nov/dec'07] [Nov/Dec'08] [May/Jun'13]
7. Compare the performance of IMPATT and TRAPATT with suitable output waveforms. (12) [Nov/Dec'07]
8. What are the high frequency limitations of bipolar devices? Draw the equivalent circuit of bipolar transistor. Mention the various biasing circuits available. (16) [Apr/May'08] [Nov/Dec'09] [Nov/Dec'11]

GOVERNMENT COLLEGE OF ENGINEERING

Sethurappatti Village, Fathima Nagar Post, Srirangam Taluk, Tiruchirappalli – 12.
(Affiliated by Anna University, Chennai)

DEPARTMENT OF ELECTRONICS AND COMMUNICATION ENGINEERING

9. Explain in detail with suitable diagrams the fabrication techniques of a monolithic microwave integrated circuit. (16/8) [Apr/May'08] [Nov/Dec'09] [Nov/Dec'08] [Apr/May'10]
10. List the basic characteristics required for an ideal substrate material. (4) [Apr/May'08]
11. Describe the principle of operation, the cases of input resistance at signal frequency and the circuit performance of parametric amplifier. (8) [Nov/Dec'08] [Nov/Dec'10]
12. Explain the construction and DC operating principle of IMPATT diode. (8) [Nov/Dec'08]
13. A Microstrip line is composed of zero thickness copper conductors on a substrate having relative dielectric constant of 8.4 (ϵ_r), dielectric loss tangent of 0.0005 and thickness of 2.4 mm. If the line width is 1 mm operated at 10 GHz, calculate the characteristic impedance and the attenuation due to conductor loss. (8/16) [Nov/Dec'08] [May/June'09]
14. Explain how the negative resistance characteristics is obtained in (16) [May/June'09]
 - ✓ Gunn Diode
 - ✓ IMPATT.
15. What are the important parameters of a Microwave transistor? (4) [May/June'09]
16. Draw the microwave equivalent circuit of a bipolar transistor (8) [May/June'09]
17. Describe the operation of tunnel diode. (8) [May/June'09] [Nov/Dec'12] [May/June'13]
18. Describe the modes of operation of Gunn diode. (8) [May/June'09] [Nov/Dec'09] [Nov/Dec'11]
19. Discuss the difference between TED and ATTD. (8) [May/June'09]
20. Distinguish between IMPATT, TRAPATT, BARITT diodes. (8) [Nov/Dec'09]
21. List the advantages and limitations of parametric amplifiers and the advantages of parametric up converter. (8) [Nov/Dec'09] [May/June'13]

GOVERNMENT COLLEGE OF ENGINEERING

Sethurappatti Village, Fathima Nagar Post, Srirangam Taluk, Tiruchirappalli – 12.
(Affiliated by Anna University, Chennai)

DEPARTMENT OF ELECTRONICS AND COMMUNICATION ENGINEERING

22. Describe the four steps of materials used in MMIC fabrication. (8) [Nov/Dec'09]
23. Explain the construction characteristics and applications of tunnel diode. (16/8)
[Nov/Dec'10] [May/Jun'11]
24. Write in detail the principle mechanism of operation and the application of varactor diode.(8) [Nov/Dec'10] [May/Jun'11] [Dec 2016]
25. Derive the power relations of a parametric amplifier. (8) [Nov/Dec'11]
26. How is varactor diode used as an oscillator? (8) [Nov/Dec'11] [Nov/Dec'12]
27. Explain the principle of operation of tunnel diode and TRAPATT diode. (16)
[Nov/Dec'13]
28. Describe the Gunn Effect with aid of two valley model theory. (8) [Nov/Dec'13]
29. Draw the physical structure and doping profile of IMPATT diode and explain in detail.
(8) [Nov/Dec'13]
30. Discuss the mounting of IMPATT device in: (16) [May/Jun'14]
- ✓ Co-axial and
 - ✓ Wave guide configuration
31. What do you understand by TED? Explain. (6) [May/Jun'14]
32. Calculate the frequency of oscillations for a stable domain mode for a 5 μ m long GaAs Gunn device. What is the minimum electron concentration? (10) [May/Jun'14]

GOVERNMENT COLLEGE OF ENGINEERING

Sethurappatti Village, Fathima Nagar Post, Srirangam Taluk, Tiruchirappalli – 12.
(Affiliated by Anna University, Chennai)

DEPARTMENT OF ELECTRONICS AND COMMUNICATION ENGINEERING **UNIT – 5**

1. Draw the equivalent of a cavity type magnetron. [Apr/May'05]
2. Compare a Barretter with a thermistor. [Apr/May'05] [May/Jun'09]
3. What are the minimum and maximum values of VSWR? Give the corresponding values of Reflection coefficients. [Apr/May'05]
4. Draw the electronic admittance spiral of REFLEX KLYSTRON. [Nov/Dec'05]
[Nov/Dec'07]
5. What are LOW VSWR and HIGH VSWR and name the method followed to measure HIGH VSWR? [Nov/Dec'05]
6. Why is the SLOT located at the centre of the SLOTTED SECTION? [Nov/Dec'05]
7. Explain why optimum RF power output from reflex klystron is more at higher magnitude of repeller voltage and lower mode. [Nov/Dec'06]
8. Explain why TWTA has a broader bandwidth than two cavity klystron amplifier. [Nov/Dec'06]
9. Why reflex klystron is square wave 1 kHz pulse amplitude modulated while microwave measurements are done using VSWR meter? [Nov/Dec'07]
10. What are the sources of error in return loss measurement using a w/g reflectometer and reflex klystron source? [Nov/Dec'06]
11. Differentiate velocity modulation and density modulation. [Nov/Dec'07]
12. Differentiate between Loaded and Unloaded 'Q' at microwave frequencies. [Nov/Dec'07]
13. What is the other name for O-type tubes? [Nov/Dec'07]
14. Mention the basic materials required for microwave integrated circuit. [Nov/Dec'07]

GOVERNMENT COLLEGE OF ENGINEERING

Sethurappatti Village, Fathima Nagar Post, Srirangam Taluk, Tiruchirappalli – 12.
(Affiliated by Anna University, Chennai)

DEPARTMENT OF ELECTRONICS AND COMMUNICATION ENGINEERING

15. Mention two methods to measure impedance. [Nov/Dec'07]
16. Define return loss and write its expression. [Nov/Dec'07]
17. For what purpose the slotted wave guides are used? [Apr/May'08]
18. Give the applications of magnetron. [Apr/May'08]
19. What is the use of slotted line with tunable probe detector? [Apr/May'08]
20. What are M- type tubes? [Apr/May'08]
21. What is the principle by which high power measurements could be done by calorimetric method? [Apr/May'08]
22. Define beam loading. [Nov/Dec'08]
23. What is meant by Hull cut-off voltage? [Nov/Dec'08]
24. What is the accuracy of phase measurement depending on while measuring the phase using reflectometer method? [Nov/Dec'08]
25. List out two differences between TWT and Multi cavity Klystron. [May/Jun'09]
26. Draw any four slow wave structures. [May/Jun'09]
27. What is 'HIGH VSWR'? [May/Jun'09]
28. Why the conventional tubes like triode, tetrode cannot generate microwave power? [May/Jun'09]
29. Mention two methods to measure microwave power. [May/Jun'09]
30. Distinguish between O – type tubes and M – type devices. [Nov/Dec'09]
31. Write the assumptions to calculate the RF power using reflex klystron oscillator. [Nov/Dec'09]
32. What does VSWR determine? [Nov/Dec'09]
33. List any two sensors used to measure the power. [Nov/Dec'09]

GOVERNMENT COLLEGE OF ENGINEERING

Sethurappatti Village, Fathima Nagar Post, Srirangam Taluk, Tiruchirappalli – 12.
(Affiliated by Anna University, Chennai)

DEPARTMENT OF ELECTRONICS AND COMMUNICATION ENGINEERING

34. Define transit time. [Apr/May'10] [May/Jun'14]

35. List any two advantages of TWT amplifier over other microwave amplifiers.

[Apr/May'10]

36. Define insertion loss. [Apr/May'10]

37. Why do we require measuring VSWR in a microwave circuits? [Apr/May'10]

38. Compare TWTA and klystron amplifier. [Nov/Dec'10] [Nov/Dec'11] [Nov/Dec'12]

[Nov/Dec'13] [Apr/May'05]

39. List the applications of reflex klystron oscillator. [Nov/Dec'10]

40. What is the use of slotted line with tunable probe detector? [Nov/Dec'10]

41. What are the main errors in the insertion loss and attenuation measurements?

[Nov/Dec'10]

42. Give the expression of RF output power in two cavity klystron amplifier. [May/June'11]

43. A helix travelling wave tube operates at 4 GHz under a beam voltage 10kV and a beam current 500mA. If the helix impedance is 25Ω and the interaction length is 20cm. find the output power gain in dB. [May/June'11]

44. What are possible errors in VSWR measurements? [May/June'11]

45. What are slow wave structures? Draw any one type of it. [Nov/dec'11]

46. Write down the basic difference between baretters and thermistors. [Nov/Dec'11]

47. For what measurements, slotted line carriage is used? What should be the minimum length of the slot in it? [Nov/Dec'11]

48. What is the purpose of slow wave structures used in TWTA? [Nov/dec'11]

49. Draw the Applegate diagram for reflex klystron. [Nov/dec'11]

50. List the various types of power measurements. [Nov/dec'11]

GOVERNMENT COLLEGE OF ENGINEERING

Sethurappatti Village, Fathima Nagar Post, Srirangam Taluk, Tiruchirappalli – 12.
(Affiliated by Anna University, Chennai)

DEPARTMENT OF ELECTRONICS AND COMMUNICATION ENGINEERING

51. What is frequency “dip” in frequency meter? [Nov/dec’11]
52. List the scales on a VSWR meter. [Nov/Dec’12]
53. Enumerate the significance of tunable detector. [Nov/Dec’12]
54. A pulsed cylindrical magnetron is operated with the following parameters. Anode voltage 25kV, beam current 25A, magnetic flux density 0.34 Wb/m^2 , radius of anode cylinder 10cm, radius of cathode cylinder 5cm, calculate angular frequency. [Nov/Dec’12]
55. Define SWR. [Nov/Dec’13]
56. List the applications of TWTA. [May/Jun’13]
57. A reflex klystron is operated at 9GHz with a DC beam voltage of 600V for $1\frac{3}{4}$ mode, repeller space length of 1mm and dc beam current of 10mA. Beam coupling coefficient to be 1. Calculate the repeller voltage. [May/Jun’13]
58. Calculate the VSWR in dB in a waveguide when the load is a 3dB attenuator by a short circuit. [May/Jun’13]
59. Define velocity modulation. [May/Jun’14] [Apr/May’08]
60. Define Q factor of a cavity. [May/Jun’14]
61. A reflex klystron is operating at 10GHz with 600V beam voltage. If the repeller voltage is 250V, determine the optimum repeller space for $1\frac{3}{4}$ mode. [May/Jun’14]
62. What is Magnetron? [Dec 2016]
63. What are Tetrodes and Pentodes? [Dec 2016]

GOVERNMENT COLLEGE OF ENGINEERING

Sethurappatti Village, Fathima Nagar Post, Srirangam Taluk, Tiruchirappalli – 12.
(Affiliated by Anna University, Chennai)

DEPARTMENT OF ELECTRONICS AND COMMUNICATION ENGINEERING **UNIT – 5 16 MARKS**

1. Draw the schematic diagram of a two cavity klystron amplifier. (4) [Apr/May'05]
2. From the first principle, derive the expression for the power output and efficiency of the two cavity klystron amplifier. (12) [Apr/May'05] [Nov/Dec'11] [May/Jun'13]
3. Draw four types of SLOW WAVE structures used in TWT. (8) [Apr/May'05]
4. For a travelling wave tube, $I_o = 300\text{mA}$, $V_o = 5\text{kV}$ and the impedance of the helix is 30 ohms. Find the length (l) of the helix that will give a gain of 60 dB at 9 GHz. (8) [Apr/May'05]
5. What are the three quantities to be measured to determine the impedance of a load at microwave frequencies? (6) [Apr/May'05] [Nov/Dec'11]
6. Draw the experimental set up to find the High VSWR and mention the procedure. (10) [Apr/May'05] [Nov/Dec'11] [Dec 2016]
7. Derive expression for the gain of a TWT. (8) [Nov/Dec'05] [May/Jun'09] [Nov/Dec'09] [May/Jun'11]
8. Derive 'HULL CUT OFF' condition and 'HARTREE' condition of a cavity type magnetron. (8) [Nov/Dec'05] [May/Jun'09] [Nov/Dec'09] [Nov/Dec'11]
9. A reflex klystron is operated at 5 GHz with dc beam voltage 1000 V, beam current 20 mA, repeller space L cm for $1\frac{3}{4}$ mode, cavity gap 2 mm, repeller voltage – 500 v. Calculate optimum repeller space, power output, efficiency and the bandwidth over $\Delta V_R = 1\text{V}$ (8) [Nov/Dec'06]
10. A cylindrical magnetron is operated at 5 GHz with cathode radius 3 cm, anode radius 5 cm, 16 resonant cavities, mode cavities, anode voltage 20kV, dc magnetic flux density

GOVERNMENT COLLEGE OF ENGINEERING

Sethurappatti Village, Fathima Nagar Post, Srirangam Taluk, Tiruchirappalli – 12.

(Affiliated by Anna University, Chennai)

DEPARTMENT OF ELECTRONICS AND COMMUNICATION ENGINEERING

0.05 T. Calculate cut-off voltage, cut-off magnetic flux density, and Hartee voltage. (8)

[Nov/Dec'06]

11. Describe the operation of tunable probe detector used in slotted line with the help of a neat diagram. What are the possible sources of error in low VSWR measurements using slotted line? (8) [Nov/Dec'06]

12. Draw a neat sketch showing the constructional features of cavity Magnetron and explain why the magnetron is referred to as crossed field device. (8) [Nov/Dec'07]

[Apr/May'08]

13. Derive an expression for cut off magnetic field for a cylindrical magnetron. (8)

[Nov/Dec'07] [Nov/Dec'09] [Nov/Dec'10] [Nov/Dec'11]

14. With a neat sketch describe the working of a Reflex Klystron. In what ways bunching in this tube differs from bunching in Multicavity tubes? Draw an Applegate diagram to illustrate bunching Draw graphs of output power when used as an oscillator and frequency deviation as a function of repeller voltage and explain the graphs. (16)

[Nov/Dec'07] [Nov/Dec'10] [May/Jun'11] [Nov/Dec'11]

15. Explain the following:

✓ Measurement of frequency by down conversion method.

✓ High power measurements by Calorimetric method. (8) [Nov/Dec'07]

[Nov/Dec'10]

16. Draw a set up to measure the insertion loss and attenuation. Enumerate the steps involved in this set up. (16) [Apr/May'08] [Nov/Dec'11]

17. Explain the measurement of load Impedance by slotted line method. (8) [Apr/May'08]

[Nov/Dec'13] [Nov/Dec'09] [Dec 2016]

GOVERNMENT COLLEGE OF ENGINEERING

Sethurappatti Village, Fathima Nagar Post, Srirangam Taluk, Tiruchirappalli – 12.
(Affiliated by Anna University, Chennai)

DEPARTMENT OF ELECTRONICS AND COMMUNICATION ENGINEERING

18. Explain the measurement of cavity 'Q' by slotted line method. (8) [Apr/May'08]
19. A reflex klystron is operated at 8 GHz with dc beam voltage of 600v for 1.75 modes, repeller space length of 1 mm, and dc beam current of 9 mA. The beam coupling coefficient is assumed to be 1. Calculate the repeller voltage, electronic efficiency and output power. (8) [Nov/Dec'08]
20. With the Applegate diagram, describe the mechanism of operation of two cavity klystron amplifier. Write the assumptions on which the analysis for RF amplification by this amplifier is based. (8) [Nov/Dec'08]
21. How can you analyze a TWTA circuit that uses a helix slow-wave resonant microwave guiding structure? (8) [Nov/Dec'08]
22. Explain the oscillation mechanism and the electron trajectory concept of magnetron oscillator. (8) [Nov/Dec'08]
23. Draw the block diagram for the slotted line method of VSWR measurement and explain. (8) [Nov/Dec'08] [Apr/May'10]
24. Explain a method for high power measurement. (8) [Nov/Dec'08] [Nov/Dec'11]
25. Draw the experimental set-up for the measurement of impedance of a discontinuity and explain. (8) [Nov/Dec'08]
26. A two cavity Klystron amplifier has the following parameters:
Beam voltage (V_{dc}) = 900 V, Beam current (I_o) = 30A, frequency = 8 GHz, gap spacing in either cavity (d) = 1 mm. Spacing between centre of cavities(s) = 4 cm. Effective shunt impedance (R_{sh}) = 40K Ω . Calculate (16) [May/Jun'09]
- ✓ Electron velocity
 - ✓ DC electron time
 - ✓ Input voltage for maximum output voltage.

GOVERNMENT COLLEGE OF ENGINEERING

Sethurappatti Village, Fathima Nagar Post, Srirangam Taluk, Tiruchirappalli – 12.
(Affiliated by Anna University, Chennai)

DEPARTMENT OF ELECTRONICS AND COMMUNICATION ENGINEERING

27. Explain with a neat figure, how TWT is used as a microwave oscillator? (10)

[May/Jun'09]

28. List and explain various applications of TWT. (6) [May/Jun'09]

29. Explain the basic principle of operation of a bolometer. (8) [May/Jun'09]

30. Describe a technique of measuring the phase shift provided by a network. (8)

[May/Jun'09]

31. Explain with a block diagram how frequency of an unknown microwave signal can be measured. (16) [May/Jun'09]

32. How do you measure VSWR through return loss measurements? (8) [Nov/Dec'09]

[Apr/May'10] [Nov/Dec'11]

33. Discuss briefly on reflex klystron tuning. (8) [Nov/Dec'09]

34. Compare the features of velocity modulation and density modulation. (8) [Nov/Dec'09]

35. Draw and explain the working of multi cavity klystron. Write the mathematical analysis of two cavity klystron. (16) [Apr/May'10]

36. Draw the appropriate diagrams and explain the working principle of: [Apr/May'10]

✓ Coaxial magnetron. (8)

✓ Helix travelling wave tubes.

(8)

37. How do you measure the following at microwave frequencies? (16) [Nov/Dec'10]

✓ VSWR

✓ Q factor.

38. How do you measure the following at microwave frequencies? (16) [May/Jun'11]

✓ VSWR

✓ Wavelength

39. With neat block diagram, explain power and impedance measurements in a microwave system. (16) [Nov/Dec'12]

GOVERNMENT COLLEGE OF ENGINEERING

Sethurappatti Village, Fathima Nagar Post, Srirangam Taluk, Tiruchirappalli – 12.
(Affiliated by Anna University, Chennai)

DEPARTMENT OF ELECTRONICS AND COMMUNICATION ENGINEERING

40. What are the high frequency limitations of conventional tubes? Explain the structure and working of TWTA? (16) [Nov/Dec'12]
41. How are microwave measurements different from low frequency measurements? Explain the double minimum methods of measuring VSWR. (16) [Nov/Dec'12]
42. A two cavity klystron operates at 5GHz with a DC beam voltage of 10kV and a 2 mm cavity gap. For a given RF voltage the magnitude of the gap voltage is 100V. Calculate the transit time at the cavity gap, the transit angle and the velocity of the electrons leaving the gap. (16) [Nov/Dec'12]
43. A normal cylindrical magnetron has the following parameters. Inner radius 0.15m, outer radius 0.45m, magnetic flux density $B_o = 1.2\text{mW/m}^2$. Determine hull cut off voltage and determine the cut off magnetic flux density if the beam voltage V_o is 6500V. Discuss various application of magnetron. (16) [May/Jun'13]
44. Explain the working principle of reflex klystron and derive the expression of bunching parameter. (16) [Nov/Dec'13]
45. Compare the performance characteristics and applications of following devices: (16) [May/Jun'14]
- | | |
|-----------------------|-----------------------|
| ✓ Klystron amplifier. | ✓ Magnetron |
| ✓ TWTA | ✓ Klystron oscillator |
46. A 250kW pulsed cylindrical magnetron is operated with the following parameters: anode voltage 25kV, peak anode current 25A, magnetic induction 0.035T, radius of cathode 4cm, radius of anode 8cm. Calculate (16) [May/Jun'14]
- | | |
|---------------------------|-------------------------|
| ✓ Efficiency of magnetron | ✓ Cutoff magnetic field |
| ✓ Cyclotron frequency | ✓ Cutoff voltage |

GOVERNMENT COLLEGE OF ENGINEERING

Sethurappatti Village, Fathima Nagar Post, Srirangam Taluk, Tiruchirappalli – 12.
(Affiliated by Anna University, Chennai)

DEPARTMENT OF ELECTRONICS AND COMMUNICATION ENGINEERING

47. Enumerate the following: (16) [May/Jun'14]

- ✓ Impedance measurement
- ✓ Measurement of cavity Q
- ✓ Frequency measurement

48. How are microwave measurements different from the low frequency measurements? (6)

[May/Jun'14]

49. Explain with the help of a neat diagram the various methods used for low and medium power measurements? (10) [May/Jun'14]

50. Explain the working principle and operation of multi-cavity klystron amplifier and derive the expressions for its output power. (16) [Dec 2016]
