

Microwave Engineering OLD IES Questions

IES-1999

1. Assertion (A): In a small flare angle pyramidal horn excited by a TE_{10} rectangular waveguide, the operative field distribution is also very nearly that of TE_{10} mode.

Reason (R): In a small flare angle horn, the throat acts as a mode filter.

- a. Both A and R are true and R is the correct explanation of A.
- b. Both A and R are true but R is not the correct explanation of A
- c. A is true but R is false
- d. A is false but R is true

2. Assertion (A): MASER is a low noise microwave source.

Reason (R): MASER operation is carried out a cryogenic temperatures.

- a. Both A and R are true and R is the correct explanation of A.
- b. Both A and R are true but R is not the correct explanation of A
- c. A is true but R is false
- d. A is false but R is true

3. Assertion (A): Fading in microwave transmission in inhomogeneous atmosphere is more severe at higher frequencies.

Reason (R): The effect of changes in path length of the microwave signal through the atmosphere increases with frequency.

- a. Both A and R are true and R is the correct explanation of A.
- b. Both A and R are true but R is not the correct explanation of A
- c. A is true but R is false
- d. A is false but R is true

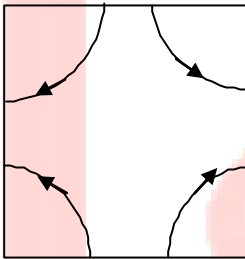
4. HEMT used in the microwave circuit is a

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- a. source
- b. high power amplifier
- c. low noise amplifier
- d. detector

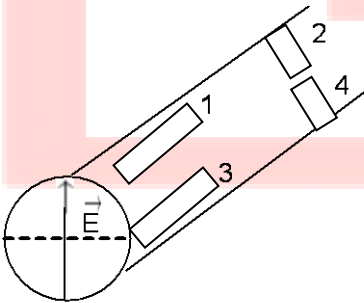
5. Given figure shows the electrical field pattern of TE_{11} mode in a square waveguide



If the waveguide cross-section is gradually deformed into a circle, the circular waveguide mode will be

- a. TE_{11}
- b. TE_{10}
- c. TE_{21}
- d. TE_{12}

6. In the circular waveguide, the slots labeled 1, 2, 3 and 4 carry TE_{11} mode as shown in the given figure



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Which one of the following is the correct set of radiating and non-radiating slots respectively?

- a. (1, 3) and (2, 4) b. (2, 3) and (1, 4)
c. (2, 4) and (1, 3) d. (1, 4) and (2, 3)

7. On terminating a waveguide. If a one-port cavity resonator produces a reflection coefficient of $0.5 < 0^\circ$; the coupling characteristics (over/under/critically) and coupling coefficients will be respectively

- a. over coupled and 2
b. under coupled and 0.5
c. over coupled and 3
d. critically coupled and 1

8. For an aperture antenna of aperture dimension D and wavelength of radiation from the antenna λ the far-field is at a distance greater than

- a. $D^2/2\lambda$ b. $2D^2/\lambda$
c. D^2/λ d. $(2D)^2/\lambda$

9. Consider the following statements about advantages and disadvantages of offset parabolic reflector antenna.

1. It reduces aperture blocking but degrades side lobe level.
2. It can be used as a multibeam or dual polarized antenna.
3. A linearly polarized illumination causes no cross-polarised components in the radiation pattern.
4. It improves isolation between reflector and primary feed.

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10. Consider the following components in a two-port transmission loss measurement setup:

1. Sweep oscillator
2. Variable attenuator
3. Device under test (DUT)
4. Power meter

The correct sequence of connection of these components is

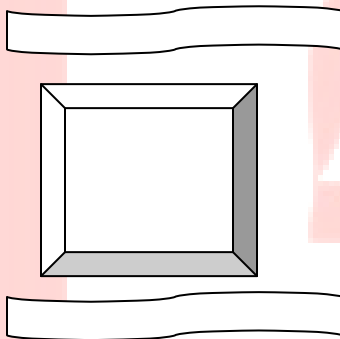
- a. 1, 2, 3, 4 b. 1, 2, 4, 3
c. 1, 2, 4, 3 d. 2, 1, 4, 3

11. On a microstrip line, the wavelength measures is 12mm for a 10GHz signal.

The dielectric constant of the equivalent homogeneous line is

- a. 3.5 b. 5.5
c. 6.25 d. 7

12. The microstrip conductor pattern shown in the given figure



is that of

- a. a loss-pass filter
b. a high-pass filter

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- c. a channel dropping filter
- d. an evanescent mode filter

13. In microwave communication links, the rain-drop attenuation experienced is mainly due to

- a. absorption of microwave energy by water vapour
- b. resonance absorption of atomic vibration in water molecules
- c. scattering of microwaves by collection of water-drops
- d. refraction of microwaves through liquid drops lenses formed by rain

14. A 1000 V source and detector sensitivity of 1 mV are connected to a long-haul transmission link of attenuation of 1 dB per 100 m. The maximum link length is

- a. 10 km
- b. 12 km
- c. 15 km
- d. 20 km

15. Consider the following statements: Ferrite is

- 1. a non-conductor with magnetic properties.
- 2. an insulator with non-magnetic properties.
- 3. a microwave semi-conductor invented by Faraday.
- 4. an insulator with gyro-magnetic properties.

Which of these statements are correct?

- a. 1 and 2
- b. 2 and 3
- c. 3 and 4
- d. 1 and 4

16. In an LOS communication system, the ground below the direct path is the first Fresnel Zone and is smooth reflecting. The phase difference between the direct and reflected waves at the receiving antenna will be

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- a. 180° b. 360°
c. 270° d. 450°

17. A cavity resonator can be represented by

- a. an LC circuit
b. an LCR circuit
c. a lossy inductor
d. a lossy capacitor

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18. A cylindrical cavity operating in TE_{111} mode has a 3dB bandwidth of 2.4 MHz and its quality factor is 4000. Its resonant frequency would be

- a. 9.6 GHz b. $9.6/\sqrt{2}$ GHz
c. $9.6/\sqrt{3}$ GHz d. $9.6/\sqrt{6}$ GHz

19. Match List-I with List-II and select the correct answer using the codes given below the lists:

List-I

- a. Ferrite circulator
b. E-plane Tee
c. Velocity modulation
d. Reflect klystron

List-II

1. Adjustable transmission line stub
2. Transit time effect
3. Pump oscillator for parametric amplifier

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4. Microwave resonator

Codes:

	A	B	C	D
a.	4	1	2	3
b.	3	2	4	1
c.	4	1	3	2
d.	3	2	1	4

20. For a Gunn diode oscillator the drift velocity of the electron is 10^7 cm/s and the active region length is 10×10^{-4} cm. The natural frequency of oscillation would be

- a. 1 MHz
- b. 10 MHz
- c. 1 GHz
- d. 10 GHz

21. At microwave frequencies, a varactor diode may not be useful

- a. for electronic tuning
- b. for frequency multiplication
- c. as an oscillator
- d. as a parametric amplifier

22. The correct sequence of the assembled parts in a klystron amplifier from any end is

- a. anode, catcher cavity, cathode and buncher cavity
- b. cathode, buncher cavity, catcher cavity and anode
- c. anode, buncher cavity, catcher cavity and cathode
- d. cathode, catcher cavity, anode and buncher cavity

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23. An amplifier network is unconditionally stable if

- real part of Z_{in} and Z_{out} are greater than zero for some positive the source and load.
- real part of Z_{in} and Z_{out} are greater than zero for all positive real impedances of the source and load
- Z_{in} and Z_{out} are complex conjugates of each other for some positive real impedances of the source and load
- Z_{in} and Z_{out} are complex conjugates of each other for all positive real impedances of the source and load

24. Consider the following statements:

If the narrow dimension of a standard rectangular waveguide carrying the dominant mode is reduced, then the

- wave impedance will increase
- attenuation will increase
- guide wavelength will decrease
- power handling capability will decrease

Which of these statements are correct?

- 1 and 2
- 2 and 4
- 3 and 4
- 1 and 3

25. A quarter-wave transformer matching a 75Ω source with a 300Ω load should have a characteristic impedance of

- 50Ω
- 100Ω
- 150Ω
- 200Ω

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26. Match List-I with List-II and select the correct answer using the codes given below the lists:

List-I

- a. Ratio of maximum energy stored to energy dissipated per cycle
- b. TEM mode in a lossless medium
- c. Ratio of frequency in radian to phase velocity of EM wave
- d. TE_{11} is the mode of lowest cut-off frequency

List-II

- 1. Propagation constant
- 2. Cut-off frequency is zero
- 3. Quality factor of a cavity
- 4. Cylindrical wave guide

Codes:

	A	B	C	D
a.	3	2	4	1
b.	2	3	1	4
c.	3	2	1	4
d.	2	3	4	1

27. An antenna has 40Ω antenna resistance and 60Ω radiation resistance. The efficiency of the antenna is

- a. 30%
- b. 40%
- c. 50%
- d. 60%

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28. For a microstrip with a substrate dielectric constant ϵ , the value of effective dielectric constant ϵ_e will be such that

a. $\frac{\epsilon}{2} < \epsilon_e < \epsilon$

b. $\frac{(\epsilon + 1)}{2} < \epsilon_e < \epsilon$

c. $1 < \epsilon_e < \frac{(\epsilon + 1)}{2}$

d. $\frac{(\epsilon - 1)}{2} < \epsilon_e < \frac{(\epsilon + 1)}{2}$

29. The insertion loss of the Device Under Test (DUT) shown in the given figure is

a. 10 dB

b. 20 dB

c. 30 dB

d. 40 dB

30. In the standing wave detector method for measuring a slightly mismatched load impedance, the distance from the load position to the nearest voltage minimum towards the generator is one-eighth the guide wavelength. The load is

a. a capacitive impedance

b. an inductive impedance

c. a pure capacitance

d. a pure inductance

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31. If the peak power of pulses microwave system is 10^4 W and the average power is 800 W, then the duty cycle will be

- a. 80%
- b. 8%
- c. 0.8%
- d. 0.8 %

32. A 8 kHz communication channel has an SNR of 30 dB. If the channel bandwidth is doubled, keeping the signal power constant, the SNR for the modified channel will be

- a. 27 dB
- b. 30 dB
- c. 33 dB
- d. 60 dB

33. Consider the following parameters:

1. Loss in the media
2. permeability of the media
3. Frequency of the wave
4. Velocity of the wave

Which of these parameters are responsible for the change of phase of a propagating electromagnetic wave?

- a. 1, 2 and 3
- b. 2, 3 and 4
- c. 1, 3 and 4
- d. 1 and 4

34. As a result of reflections from a plane conducting wall, electromagnetic waves acquire an apparent velocity greater than the velocity of light in space. This is called the

- a. velocity of propagation
- b. normal velocity
- c. group velocity

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d. phase velocity

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35. While determining antenna height for terrestrial microwave links, the effect of refraction from the atmosphere is taken care of by considering the effective curvature of the earth to be

- a. $2/3$ times the radius of the earth
- b. $3/4$ times the radius of the earth
- c. $4/3$ times the radius of the earth
- d. $3/2$ times the radius of the earth

36. Match List-I (Microwave band) with List-II (Frequency used in satellite communication) and select the correct answer using the codes given below the lists:

List-I

- a. C-band
- b. Ku-band
- c. Ka-band

List-II

- 1. 12 GHz to 14 GHz
- 2. 24 GHz to 26 GHz
- 3. 20 GHz to 30 GHz
- 4. 4 GHz to 6 GHz

Codes:

	A	B	C
a.	4	2	1
b.	2	1	3
c.	4	1	3
d.	3	4	2

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37. For a parabolic reflector antenna with diameter of 3m, the far field pattern measurement at 10 GHz should be carried out at a distance of a least

- a. 30 m
- b. 200 m
- c. 400 m
- d. 600 m

38. In Gunn oscillator where the diode is operated in a tunable resonant circuit, most of the sample length of the Gunn device is maintained in the negative conductance state during most of the R.F. cycle for

- a. delayed domain mode
- b. quenched domain mode
- c. LSA mode
- d. hybrid mode

39. Match List-I (Names of the devices) with List-II (Applications) and select the correct answer using the codes given below the lists:

List-I

- a. Step- recovery diodes
- b. MESFET
- c. Pin Diode

List-II

- 1. Switching circuit
- 2. To produce multiple harmonics in comb generator
- 3. Microwave amplifier

Codes:

- | | A | B | C |
|----|---|---|---|
| a. | 2 | 1 | 3 |

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- b. 2 3 1
c. 3 2 1
d. 1 3 2

40. Consider the following statements:

Cross field amplifier (CFA) is a microwave power amplifier which

1. is a cross between the TWT and the magnetron in its operation
2. uses a magnetron structure to provide an interaction between crossed dc electric and magnetic field on one hand and RF fields on the other hand.
3. Uses interaction between electron beam and stationary RF fields.

Select the correct answer using the codes given below:

- a. 1 and 2 b. 1 and 3
c. 3 alone d. 2 and 3

41. Broad banding a microwave transistor RF amplifier is difficult because

- a. of shunt capacitance loading effect
- b. of series capacitance loading effect
- c. changes in inductive loading
- d. changes in output loading affect input impedance

42. The propagation of TE_{10} mode in a rectangular waveguide is used to excite a circular waveguide as shown in figure-I and figure-II. The mode excited in the circular waveguide of figure-I and figure-II will, respectively, be

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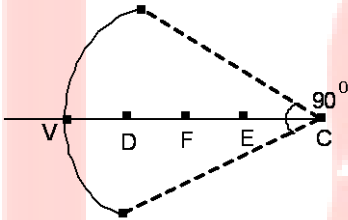
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- a. TE_{11} and TM_{01} b. TM_{01} and TE_{11}
b. TE_{01} and TM_{01} d. TM_{01} and TE_{01}

43. For producing circularly polarized beams in microwave communication field, the type of antenna ideally suited is

- a. helical antenna
b. parabolic disc circular aperture
c. pyramidal horn with symmetrical beam shapes in E and H plane
d. circular loop antenna

44. Given figure shows a 90° sector of spherical reflector with vertex 'V', centre of curvature 'C' and equal distance VD, DF, FE and EC. When a beam of electromagnetic wave is incident parallel to the axis, all the energy will pass through the region



- a. VD b. DF
c. FE d. EC

45. A cylindrical cavity resonator has diameter of 24 mm and length 20 mm;. The dominant mode and the lowest frequency band are operated as

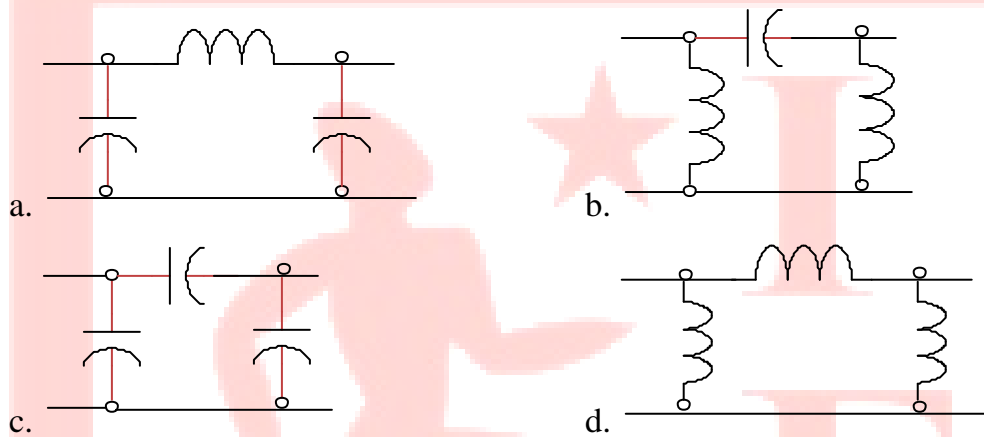
- a. TE_{111} and X-band

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- b. TM_{111} and C-band
- c. TM_{011} and Ku-band
- d. TM_{110} and X-band

46. The equivalent circuit of a gap in the strip conductor of a microstrip is



47. In parametric amplifier used in microwave communication systems, the gain is mainly restricted by

- a. ambient temperature
- b. pump frequency
- c. pump bandwidth
- d. pump energy

48. Two identical antennas 1 km apart and operating at $\lambda = 10$ cm in an LOS link, have an obstacle 10m high midway between them. The height of the antennas such that the first Fresnel zone is free of any obstacle, should be

- a. 15 m
- b. 18 m
- c. 20 m
- d. 25 m

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49. In the measurement of microwave signal as shown in the given figure, the power meter reads $0.01 \mu\text{W}$. The coupler directivity is

- a. 20 dB
- b. 30 dB
- c. 40 dB
- d. 50 dB

50. Assertion (A): One problem with micro strip circuits (or other planar circuits) is that of inevitable discontinuities at bends, step changes in width, and junctions which can cause a degradation of circuit performance.

Reason (R): Bends, step changes in width and junction discontinuities introduce parasitic reactance's that can lead to phase and amplitude errors, input and output mismatch, and spurious coupling.

- a. Both A and R are true and R is the correct explanation of A.
- b. Both A and R are true but R is not the correct explanation of A
- c. A is true but R is false
- d. A is false but R is true

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51. The correct sequence of subsystems of Klystron amplifier as they appear in the direction of flow of the electron beam is

- a. Buncher cavity, cathode, collector, catcher cavity.
- b. Buncher cavity, cathode, catcher cavity, collector

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- c. cathode, Buncher cavity, catcher cavity, collector
- d. cathode, Buncher cavity, collector catcher cavity

52. Assertion (A): GaAs is preferred to silicon for fabrication of Gunn diode

Reason (R): GaAs has better frequency stability than silicon

- a. Both A and R are true and R is the correct explanation of A.
- b. Both A and R are true but R is not the correct explanation of A
- c. A is true but R is false
- d. A is false but R is true

53. Assertion (A): TE_{10} mode is the dominant mode in a rectangular wave guide.

Reason (R): TE_{10} mode has the lowest cut off frequency for which the wave length is double the broad wall dimension.

- a. Both A and R are true and R is the correct explanation of A.
- b. Both A and R are true but R is not the correct explanation of A
- c. A is true but R is false
- d. A is false but R is true

54. An IMPAT diode has a drift length of $4 \mu\text{m}$. The drift velocity of Si is 10^5 m/s .

The operating frequency of the IMPAT diode is

- a. 25 GHz
- b. 20 GHz
- c. 12.5 GHz
- d. 125 GHz

55. Match List-I (Microwave device) with List-II (Interaction process involved) and select the correct answer using the codes given below the lists:

List-I

- a. Reflect Klystron

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- b. Gyrotron modulation
- c. Backward wave
- d. Fixed-frequency

List-II

1. Spiralling beam
2. Velocity with traveling wave structure
3. Velocity modulation oscillator with resonant cavities
4. Crossed field magnetron

Codes:

	A	B	C	D
a.	4	2	1	3
b.	3	1	2	4
c.	4	1	2	3
d.	3	2	1	4

56. For using as a local oscillator for frequency measurements, the most suitable microwave source would be

- a. Travelling wave tube
- b. Double cavity klystron
- c. Reflex klystron
- d. Magnetron

57. Electromagnetic oscillations are sustained in a two-cavity klystron due to

- a. feedback of output power to the input cavity in proper phase
- b. feedback of output power to the input cavity with phase difference of 180°

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- c. feedback of power from external load to input cavity in proper phase
- d. feedback of power from the thermal noise of load circuit with phase lag of 90° .

58. Match List-I (Circuit name) with List-II (S-parameter) and select the correct answer using the codes given below the lists:

List-I

- a. Circulator (3-port)
- b. Directional Coupler
- c. Magic Tee
- d. Rat Race Junction

List-II

1.
$$\begin{bmatrix} 0 & S_{12} & 0 & S_{14} \\ S_{12} & 0 & S_{23} & 0 \\ 0 & S_{23} & 0 & S_{34} \\ S_{14} & 0 & S_{34} & 0 \end{bmatrix}$$

2.
$$\begin{bmatrix} 0 & S_{12} & S_{13} & S_{14} \\ S_{21} & 0 & S_{23} & S_{24} \\ S_{31} & S_{32} & 0 & S_{34} \\ S_{41} & S_{42} & S_{43} & 0 \end{bmatrix}$$

3.
$$\begin{bmatrix} 0 & S_{12} & S_{13} \\ S_{12} & 0 & S_{23} \\ S_{13} & S_{23} & S_{33} \end{bmatrix}$$

4.
$$\begin{bmatrix} 0 & 0 & 1/\sqrt{2} & 1/\sqrt{2} \\ 0 & 0 & 1/\sqrt{2} & -1/\sqrt{2} \\ 1/\sqrt{2} & 1/\sqrt{2} & 0 & 0 \\ 1/\sqrt{2} & -1/\sqrt{2} & 0 & 0 \end{bmatrix}$$

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3. Existence of low signal losses.

4. Lower interference due to lower signal crowding.

Use of RF/ microwaves in system application results in which of these advantages?

- a. 1, 2 and 4 b. 1, 3 and 4
c. 2, 3 and 4 d. 1, 2 and 3

63. In a VSWR measurement, a square law detector is used to detect the signal level, The voltmeter reads maximum and minimum as 64 mV and 16 mV respectively. The VSWR of the system will be

- a. 4 b. 2
c. 8 d. 16

64. Resistive films in MIC's are needed to fabricate resistors and attenuators. The features desirable in resistive films are

- a. low temperature coefficient of resistance (TCR)
b. lower loss
c. good adhesion to the substrate
d. good etchability and solderability

65. The type of antenna to be used for producing circularly polarized beams is

- a. pyramidal horn b. log-periodic array
c. paraboloid d. helical antenna

66. In a material characterized by a complex permittivity the imaginary part is a measure of

- a. dielectric strength of the material

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- b. energy stored in the electric field
- c. losses in the material
- d. energy stores in the magnetic field

IES-2003

67. In a reflex klystron, the velocity modulation

- a. Occurs near the reflector
- b. Occurs in the resonator gap
- c. Occurs near the accelerating grid
- d. Does not occur at all

68. For a Gunn diode, the drift velocity of electron through active drift region is 10^7 cm/s and the active regions is 10×10^{-4} cm. The critically voltage of the diode (critical field = 3.2 kV/cm) is

- a. 0.032 V
- b. 0.32 V
- c. 3.2 V
- d. 32 V

69. As an ideal local oscillator for microwave frequency measurements, the most suitable microwave source is a

- a. Multicavity magnetron
- b. Reflex klystron
- c. Double cavity klystron
- d. Traveling wave tube

70. The maximum theoretical output circuit efficiency of a double resonator klystron amplifier is

- a. 25%
- b. 50%

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c. 58%

d. 85%

71. Which one of the following can be used for amplification of microwave signals?

- a. Gunn diode
- b. Strapped magnetron
- c. Reflex klystron
- d. Double cavity klystron

72. If the height of the waveguide is halved, its cut-off wavelength will

- a. Be halved
- b. Be doubled
- c. Remain unchanged
- d. Be one-fourth of the previous value

73. In a rectangular waveguide with broader dimension a and narrow dimension b , the dominant mode of microwave propagation would be

- a. TE_{10}
- b. TM_{10}
- c. TE_{01}
- d. TM_{01}

74. A cavity wave meter is connected parallel to a waveguide transmission line which terminates in a resistive load. The microwave power reaching the load end is monitored by a power meter. As the cavity wave meter is tuned to the resonant frequency of the input signal through the waveguide assembly the power indicated by the power meter will show

- a. A sudden dip
- b. A sudden rise

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- c. rapid fluctuations
- d. A steady level

75. A two-port non-reciprocal device which produces a minimum attenuation to e.m. wave propagation in one direction and a very high attenuation in opposite direction is generally known as

- a. phase shifter
- b. isolator
- c. Polariser
- d. circulator

76. A metal probe inserted into a rectangular waveguide through the broader wall of the guide will provide a property across the guide. This property is

- a. Shunt
- b. Reactance
- b. Reverberation
- d. Resonance

77. Typical f/D ratio in practice for a paraboloid reflector (where f is the focal length and D is the aperture diameter) is in the range of

- a. 0.2 to 0.3
- b. 2 to 3
- c. 0.02 to 0.03
- d. 0.5 to 1

78. A parabolic dish antenna has a diameter of 1m. the maximum possible (ideal) gain of the antenna at a wavelength of 3.14 cm is

- a. 20 dB
- b. 30 dB
- c. 40 dB
- d. 50 dB

79. A slotted line is used for the measurement of VSWR. The slot is cut at the centre, because

- a. The field a good impedance matching

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- b. To get a good impedance matching
- c. Maximum field will be induced to the penetrating probe
- d. No field will be coupled to the probe

80. In a microwave measurement set-up the power reaching to the load is found to be 50mW. If a 3dB coupler is placed before the load, the power to the load will be

- a. 50 mW
- b. 25 mW
- c. 12.5 mW
- d. 6.25 mW

81. The variation of resistance of an element with absorption of microwave power is the underlying principle of operation of a/an

- a. Attenuator
- b. Wave filter
- c. Phase shifter
- d. Bolometer

82. In microwave communication links, path diversity and frequency diversity are adopted to overcome fading in the path due to

- a. polarization shifting
- b. phase lagging
- c. Rain attenuation
- d. For accumulation

83. In microwave communication systems, using circularly polarized beams, the receiving antenna should be

- a. Helical antenna
- b. Horn antenna
- c. Crossed rhombic antenna
- d. Biconical loop antenna

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84. The extended range propagation occurs due to

- a. High conductivity of the ground
- b. Low conductivity of the ground
- c. Blobs of different dielectric constants randomly distributed in the volume of the upper atmosphere
- d. High conductivity of the upper atmosphere

85. In LOS-line of sight propagation systems, to take account of normal refraction an effective earth radius factor K is used whose value is

- a. $4/3$
- b. 4
- c. $3/4$
- d. $1/2$

86. Which one of the following frequency bands is allocated by ITU (International Telecommunication Union) for DBS-Direct Broadcast Service (also referred as DTH-Direct to Home service)?

- a. 14/12 GHz
- b. 6/4 GHz
- c. 2/1 GHz
- d. 42/40 GHz

IES-2004

87. Match List-I (Designation of Radar Frequencies) with List-II (Frequency Range) and select the correct answer using the codes given below the lists:

List-I	List-II
a. S	1. 18-26.5 GHz
b. X	2. 2-4 GHz
c. Ku	3. 8-12.4 GHz

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Which of the statements given above are correct?

- a. 1 and 2
- b. 2 and 4
- c. 2 and 3
- d. 1, 3 and 4

91. In a Ga As Gunn diode the drift velocity is 10^7 cm/s and active region length is 10^{-3} cm. What is the natural frequency of oscillation?

- a. 8 GHz
- b. 9 GHz
- c. 10 GHz
- d. 11 GHz

92. Consider the following pairs:

1. Travelling wave tube: linear electron beam
2. Cavity Magnetron: Strapping
3. Amplitron : CFA

Which of the pairs given above are correctly matched?

- a. 1, 2 and 3
- b. 1 and 2
- c. 2 and 3
- d. 1 and 3

93. A rectangular waveguide operating in the dominant mode is gradually deformed into circular cross-section in the direction of propagation. What is the mode at the output?

- a. TM_{11}
- b. TE_{11}
- c. TE_{01}
- d. TM_{01}

94. A “mode filter” has the structure of thin radial wires in a circular wave guide as shown in the diagram given below:

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97. A 50 ohm coaxial line is connected to a 72 ohm load through a 60 ohm coaxial section of length 7.5mm. What is the input VSWR on the line if it is fed by a 20 GHz source?

- a. 1.0 b. 1.25
c. 1.33 d. 1.44

98. Match List with List-II and select the correct answer using the codes given below the lists:

List-I

- a. Helical antennas
b. Dipoles
c. Parabolic dish
d. Array antennas

List-II

1. Isotropic radiator
2. Circulatory polarized radiation
3. Shaped beams
4. Satellite communication systems

Codes:

	A	B	C	D
a.	1	2	4	3
b.	1	2	3	4
c.	2	1	4	3
d.	2	1	3	4

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Microwave Engineering OLD IES Questions

99. Match List –I with List-II and select the correct answer using the codes given below the lists:

List-I

- a. Cavity wave meter
- b. Magic Tee
- c. VSWR
- d. Bolometer

List-II

- 1. Microwave component
- 2. Microwave power measurement
- 3. Microwave frequency measurement
- 4. Reflection coefficient measurement

Codes;

	A	B	C	D
a.	4	2	3	1
b.	3	2	4	1
c.	4	1	3	2
d.	3	1	4	2

100. Two one-port cavity resonators having coupling coefficients K_1 and K_2 and identical resonant frequency ω_0 produce identical VSWR when used as terminating loads of a waveguide. Which one of the following relations is satisfied by K_1 and K_2 ?

- a. $K_1 - K_2 = 0$
- b. $K_1 K_2 = 0$
- c. $K_1 K_2 = \frac{1}{2}$
- d. $K_1 + K_2 = 1$

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101. Which is the most common antenna to obtain a predetermined radiation pattern?

- a. Array antenna
- b. Corner reflector
- c. Sectoral horn
- d. Helical antenna

102. Assertion (A): For a slow wave structure helix is a broadband low-power device while coupled-cavity chain in a narrow band high power device.

- a. Both A and R are true and R is the correct explanation of A.
- b. Both A and R are true but R is not the correct explanation of A
- c. A is true but R is false
- d. A is false but R is true

IES-2005

103. Assertion (A): Microstrip lines are preferred for antenna application.

Reason (R): They have higher 'Q' and higher Gain.

- a. Both A and R are true and R is the correct explanation of A.
- b. Both A and R are true but R is not the correct explanation of A
- c. A is true but R is false
- d. A is false but R is true

104. A four port ideal directional coupler with infinite directivity is characterized by a S-matrix given as

a.
$$\begin{bmatrix} 0 & S_{12} & S_{13} & S_{14} \\ S_{21} & 0 & S_{23} & S_{24} \\ S_{31} & S_{32} & 0 & S_{34} \\ S_{41} & S_{42} & S_{42} & 0 \end{bmatrix}$$

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b.
$$\begin{bmatrix} 0 & S_{12} & 0 & S_{14} \\ S_{21} & 0 & S_{23} & 0 \\ 0 & S_{32} & 0 & S_{34} \\ S_{41} & 0 & S_{43} & 0 \end{bmatrix}$$

c.
$$\begin{bmatrix} 0 & 0 & S_{13} & S_{14} \\ 0 & 0 & S_{23} & S_{24} \\ S_{31} & S_{32} & 0 & 0 \\ S_{41} & S_{42} & 0 & 0 \end{bmatrix}$$

d.
$$\begin{bmatrix} S_{11} & S_{12} & 0 & 0 \\ S_{21} & S_{22} & 0 & 0 \\ 0 & 0 & S_{33} & S_{34} \\ 0 & 0 & S_{43} & S_{44} \end{bmatrix}$$

(Assuming that port 1, 2 are on one line, and port 3, 4 are on the auxiliary line)

105. Match List-I with List-II and select the correct answer using the codes given below the lists:

List-I

- VSWR meter
- T-R Tube
- Reciprocity Theorem
- Bolometer

List-II

- Antenna measurements
- Microwave power measurements
- Duplexers
- Reflection Coefficient measurements

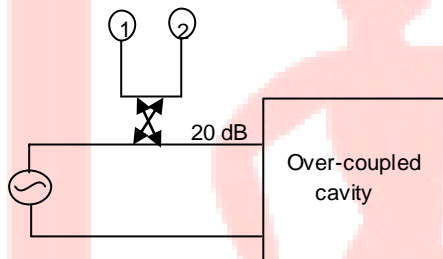
Codes:

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Microwave Engineering OLD IES Questions

	A	B	C	D
a.	4	1	3	2
b.	2	3	1	4
c.	4	3	1	2
d.	2	1	3	4

106. In the system shown above the input VSWR is 1.5 at resonance. If the power meter 12 reads 1 mW, What is the reading on the power meter 2?



- | | |
|-----------|------------|
| a. 0.1 mW | b. 0.06 mW |
| c. 0.4 mW | d. 0.02 mW |

107. Match List-I (Antenna) with List-II (Property) and select the correct answer using the codes given below the lists:

List-I

- Log periodic antenna
- Helical antenna
- Microstrip antenna
- Dipole antenna

List-II

- Circular polarization
- Wide bandwidth

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3. Omni directional pattern
4. Compact and light weight

Codes:

	A	B	C	D
a.	3	1	4	2
b.	2	4	1	3
c.	3	4	1	2
d.	2	1	4	3

108. Match List-I with List-II and select the correct answer using the codes given below the lists:

List-I

- a. Helical antenna
- b. Pyramid horn
- c. Microstrip patch
- d. Sector horn

List-II

1. Fan-shaped beam, high power handling
2. Low bandwidth, low antenna power handling
3. Narrow beam, high antenna power handling
4. currently polarised antenna beam, moderate power handling

Codes:

	A	B	C	D
a.	4	3	2	1
b.	2	1	4	3

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- c. 4 1 2 3
d. 2 3 4 1

109. For a parabolic reflector of 5 meter diameter, the far field pattern measurement at 6 GHz should be carried out a distance of at least

- a. 0.5 km b. 1.0 km
c. 1.5 km d. 2.0 km

110. A microstrip line of 50 ohm is terminated in $Z_L = 40 + j30 \Omega$. What is the VSWR of the load?

- a. 2.0 b. 1.8
c. 1.5 d. 1.3

111. In an air-filled waveguide of dimensions a cm x b cm, at a given frequency, the longitudinal component of electric field of TM_{32} mode is of the form $E_z = 20 \sin(60\pi x) \sin(10\pi y)$.

Which form would E_z have for the lowest order TM mode?

- a. $E_z = 20 \sin(20\pi x)$
b. $E_z = 20 \sin(20\pi y)$
c. $E_z = 20 \sin(20\pi x) \sin(50\pi y)$
d. $E_z = 20 \sin(20\pi x) \sin(100\pi y)$

112. For a rectangular waveguide of dimension $\sqrt{3}$ cm x a cm the cut off frequency, for the TE_{10} mode is 2GHz.

What is the cut off frequency for TM_{11} mode in the wave guide?

- a. 1 GHz b. 3.46 GHz
c. 4 GHz d. 6 GHz

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113. If TE_{10} mode propagates in the rectangular waveguide. Which is the lowest mode excited in the circular waveguide?

- a. TE_{11} b. TM_{11}
c. TE_{01} d. TM_{01}

114. The Magic-T (or Tee) is commonly used in mixing, duplexing and impedance measurement at microwave frequencies. It is characterized by a S-matrix given as

a.
$$\begin{bmatrix} 0 & S_{12} & S_{13} & S_{14} \\ S_{21} & 0 & S_{23} & S_{24} \\ S_{31} & S_{32} & 0 & S_{34} \\ S_{41} & S_{42} & S_{42} & 0 \end{bmatrix}$$

b.
$$\begin{bmatrix} 0 & S_{12} & 0 & S_{14} \\ S_{21} & 0 & S_{23} & 0 \\ 0 & S_{32} & 0 & S_{34} \\ S_{41} & 0 & S_{43} & 0 \end{bmatrix}$$

c.
$$\begin{bmatrix} 0 & 0 & S_{13} & S_{14} \\ 0 & 0 & S_{23} & S_{24} \\ S_{31} & S_{32} & 0 & 0 \\ S_{41} & S_{42} & 0 & 0 \end{bmatrix}$$

d.
$$\begin{bmatrix} S_{11} & S_{12} & 0 & 0 \\ S_{21} & S_{22} & 0 & 0 \\ 0 & 0 & S_{33} & S_{34} \\ 0 & 0 & S_{43} & S_{44} \end{bmatrix}$$

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115. N represents the number of electron transit cycles in the drift space of a two cavity klystron amplifier. What is the phase difference between the input signal voltage and the output current of the amplifier?

- a. $(\pi/2 - 2\pi N)$ b. $(\pi/2 + 2\pi/N)$
c. $(\pi - 2\pi N)$ d. $(\pi + 2\pi N)$

116. Why is an attenuator used in a TWT?

- a. To help bunching
b. To prevent oscillations
c. To prevent saturation
d. To increase gain

117. Match List-I with List-II and select the correct answer using the codes given below the lists;

List-I

- a. Reflex klystron
b. Double cavity
c. Gunn diode
d. Magnetron

List-II

1. Amplification
2. Mode jumping klystron
3. Electron bunching
4. Negative resistance

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Codes;

	A	B	C	D
a.	4	3	1	2
b.	3	1	4	2
c.	4	3	2	1
d.	3	2	4	1

118. In the Gunn diode, out of its various modes of operation, one mode is independent of domain transit time and hence can be used at high frequency and for very high output powers. Which is this mode?

- a. Transit time mode
- b. Quenched domain mode
- c. Delay domain mode
- d. Limited space charge accumulation mode

119. Consider the following statements:

The analysis of oscillations based on typical semiconductor device cannot be extended at high frequency because:

- 1. It does not show negative mobility
- 2. It does not shown negative resistance.
- 3. The transit time between junctions becomes high
- 4. The junction capacitance becomes very large.

Which of the statements given above are correct?

- a. 1 and 2
- b. 3 and 4
- c. 1, 2 and 4
- d. 1, 2, 3 and 4

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120. In terrestrial microwave links, the number of 'fades' per unit time increases as

- a. Both the transmission frequency and the distance between the antennas are increased
- b. The transmission frequency is increased but the distance between the antennas is decreased
- c. The transmission frequency is decreased but the distance between the antennas is increased.
- d. Both the transmission frequency and the distance between the antennas are decreased

121. In parametric amplifiers used in microwave communication systems, the pump energy is the deciding factor for which one of the following?

- a. Frequency stability
- b. Maximum output
- c. Amplification factor
- d. Thermal noise level

122. By using a traveling wave structure in a maser, we may

- a. Increase the bandwidth of operation
- b. Increase the power output
- c. Stabilize the frequency of operation
- d. Minimize the noise level and distortion

123. Match List-I (Meter/Theorem) with List-II (Measurement) and select the correct answer using the codes given below the lists:

List-I

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- a. Bolometer
- b. Reciprocity Theorem
- c. VSWR meter
- d. Cavity wavemeter

List-II

- 1. Antenna measurements
- 2. Microwave power measurements
- 3. Reflection coefficient measurements
- 4. Microwave frequency measurements

Codes:

	A	B	C	D
a.	3	1	2	4
b.	2	4	3	1
c.	3	4	2	1
d.	2	1	3	4

124. Assertion (A): In microwave communication links, rain causes fading and this is a great concern in communication systems.

Reason (R): Water droplets in the path of an electromagnetic wave will scatter the energy in the waves and this collective scattering will weaken the incident wave in the forward direction.

- a. Both A and R are true and R is the correct explanation of A.
- b. Both A and R are true but R is not the correct explanation of A
- c. A is true but R is false
- d. A is false but R is true

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125. The two-valley model of the Ridley Watkins Hilsum theory is best suited to explain the working of which one of the following?

- a. Quartz crystal oscillator
- b. Gunn Diode oscillator
- c. Klystron oscillator
- d. R-C oscillator

126. The working of a traveling wave tube is based on the interaction between

- a. Moving electrons and the transverse component of a progressive e.m. wave
- b. Moving electrons and the axial component of a progressive e.m. wave
- c. Moving electrons and the transverse component of a rotating magnetic field.
- d. Moving electrons and the axial component of a steady magnetic field.

127. Which of the following are microwave sources?

- a. Klystron
- b. Magnetron
- c. IMPATT
- d. TWTA

128. To prevent oscillations in the TWT which one of the following is resorted to?

- a. Bunching defocusing mechanism is used.
- b. Attenuator is used
- c. External magnetic field is provided
- d. Helix is used

129. Which of the following microwave components has got the combined characteristics of dielectric ohmic and radiation losses?

- a. Waveguide
- b. Microstrip line

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- c. Co-axial line d. Parallel twin line

130. By measuring the VSWR values in the main and ancilliary wave guides of a directional coupler, we can determine its

- a. phase co-relation and efficiency
- b. Frequency shift and phase variations
- c. Attenuation and radiation efficiency
- d. Directivity and coupling factor

131. Which one of the following express the phase velocity in microstrip lines/

- a. C/ϵ_e
- b. $C/\sqrt{\epsilon_e}$
- c. $C \cdot \epsilon_e$
- d. $\sqrt{\epsilon_e} \cdot C$

132. Consider the following statements about microstrips:

- 1. Microstrips are operated under the conditions where the substrate thickness $\gg \lambda_0$.
- 2. When the substrate thickness $\gg \lambda_0$ the line is dispersive.
- 3. As the frequency of operation increases, the phase velocity on the line decreases and approaches the velocity in free space.

Which of the statements given above is/are correct?

- a. 1, 2 and 3
- b. Only 1 and 3
- c. Only 2
- d. Only 1 and 2

IES-2007

133. Match List-I (Component) with List-II (Filtering Characteristics) and select the correct answer using the code given below the lists:

List-I

- a. Coaxial line

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- b, Rectangular wave guide
- c. Cavity resonator
- d. Common wavemeter

List-II

1. Band pass filter
2. Band reject filter
3. Low pass filter
4. High pass filter

Codes:

	A	B	C	D
a.	1	2	3	4
b.	1	2	4	3
c.	3	4	2	1
d.	3	4	1	2

134. Assertion (A): Substrate chosen for fabrication of microstrip lines is usually thin and having high value of dielectric constant.

Reason (R): To minimize radiation loss from microstrip lines, fringing of fields loss from microstrip as much as practicable.

- a. Both A and R are true and R is the correct explanation of A.
- b. Both A and R are true but R is not the correct explanation of A
- c. A is true but R is false
- d. A is false but R is true

135. X-band frequencies are in which one of the following ranges?

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- a. 3.5 to 5.5 GHz b. 5.5 to 8.0 GHz
c, 8.0 to 12.0 GHz d. 12.4 to 16.4 GHz

136. Match List-I (Medium) with list-II (Type of Radio Waves) and select the correct answer using the code given below the lists:

List-I	List-II
a. Microstrip line	1. Surface wave
b. Earth crust	2. Guided wave
c. Troposphere	3. Sky wave
d. Ionosphere	4. Space wave

Codes:

	A	B	C	D
a.	1	2	3	4
b.	1	2	4	3
c.	2	1	3	4
d.	2	1	4	3

137. match List-I (Device) with List-II (Associated Term) and select the correct answer using the code given below the lists:

- List-I
- a. Gunn diode
b. Impatt
c. Klystron
d. Parametric amplifier

List-II

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1. Bunching
2. Avalanche breakdown
3. LSA mode
4. UP-converter

Codes:

	A	B	C	D
a.	3	2	4	1
b.	3	2	1	4
c.	2	3	4	1
d.	2	3	1	4

138. In traveling wave tube microwave amplifiers, the velocity modulation and bunching of electrons are achieved by the electromagnetic wave supported in the slow wave structure.

Which one of the following field components is responsible for the above?

- a. The electric field component transverse to the electron beam propagation
- b. The electric field component in the direction of the electron beam propagation
- c. The magnetic field component transverse to the electron beam propagation
- d. The magnetic field component in the direction of the electron beam propagation

139. In a klystron amplifier, the interaction between the electron beam and the radio frequency wave in the re-entrant cavity depends upon the average gap transit angle θ_g . What is this transit angle?

- a. The angle at which the electron beam leaves the central gap of the re-entrant cavity

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- b. The angle at which the electron beam enters the central gap of the re-entrant cavity.
- c. The angle at which the electron beam diffracts from the central gap of the reentrant cavity
- d. The phase change due to finite time, the electron beam takes to cross the central gap of the re-entrant cavity

140. Why is a reflex klystron oscillator preferred as an ideal source in microwave measurements?

- a. It provides high power output with wide frequency range
- b. It provides high power output with single frequency
- c. It provides low power output with highly stable single frequency
- d. It provides low power output with multiple frequency components

141. To avoid difficulties with strapping at high frequencies, what type of cavity structure is used in the magnetron?

- a. Hole and slot
- b. Slot
- c. Vane
- d. Rising sun

142. A duplexer is used for which one of the following?

- a. To couple two antennas to a transmitter without interference
- b. To isolate the antenna from local oscillator
- c. To prevent interference between two antennas connected to a receiver.
- d. To use same antenna for reception or transmission without interference.

143. Which one of the following has the combined characteristics of dielectric ohmic and reflection losses?

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- a. Coaxial line b. Twin parallel line
c. Microstrip line d. Waveguide

144. In a microwave circuit with waveguides, what is a 'waveguide twist' used for?

- a. Impedance matching
b. Phase shifting
c. Rotating pointing vector
d. Rotating plane of polarization

145. The wave guide = 1.5 cm b = 1 cm) is loaded with electric ($\epsilon_r = 4$). Which one of the following is correct?

The 8 GHz signal will

- a. pass through the waveguide
b. not pass through the wave guide
c. be absorbed in the guide
d. none of the above

146. Two microwave signals, traveling in the free space have a path length difference of 3 cm when operating at 10 GHz. What is the relative phase difference of the signals.

- a. 2π b. π
c. 3π d. 4π

147. In a dielectric medium of ϵ_r (given $n = \sqrt{\epsilon_r}$), what is the expression for the wavelength (λ) of a microwave signal?

- a. c/n^2f b. nc/f

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- c. c/nf d. None of these

148. In the terrestrial paths of a microwave communication system, which technique is usually adopted to overcome signals loss due to earth's curvature?

- a. Link repeaters are arranged with 50 km apart
b. Link repeaters are arranged with 500 km apart
c. Signal amplifiers are arranged in every 5 km apart
d. Phase correctors are located in every 2 km apart

149. An amplifier has a power gain of 200. What is its gain in dB? ($\log_{10} 2 = 0.30$)

- a. 14 dB b. 17 dB
c. 20 dB d. 23 dB

150. Bandwidth of the order of 12 MHz can be realized easily using carriers in which range?

- a. VHF
b. UHF
c. Microwaves only
d. Optical frequency and microwaves

IES-2008

151. In reflex klystrons the adjustment of volume of the anode cavity will result in change of

- a. output power
b. output pulse width
c. output frequency of operation
d. output signal to noise ratio

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152. The main purpose of inserting a microwave isolator in a microwave circuit is for

- a. offering minimum forward impedance
- b. offering maximum power output from the source
- c. maintaining frequency stability of the source
- d. maintaining amplitude stability of output power

153. The underlying principle of working of a cavity wave meter, used to measure frequency of microwaves in a system, is

- a. selective absorption of microwave energy in solids
- b. selective scattering of microwave energy by a cavity
- c. selective diffraction of microwaves around a cavity
- d. resonance of a cavity with incoming microwave energy

154. In microwave communication links, what causes intense fading in the 18 GHz band?

- a. Snow
- b. Rain
- c. Fog
- d. Dust

155. In measuring pulsed microwave power, the pulse duration is $1.5 \mu\text{s}$ with PRF of 1 kHz. If the CW power sensor reads 15 mW. What is the average signal power during the pulse?

- a. 5 W
- b. 10 W
- c. 15 W
- d. 20 W

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156. For obtaining a beam of electromagnetic waves with circular polarization, what is the ideal antenna?

- a. A double conical reflector
- b. A helical antenna
- c. A pyramid horn antenna
- d. A hog-horn antenna

157. A microwave antenna –characteristics are described as low weight low power handling capacity and low bandwidth. What shall this be?

- a. Helical antenna
- b. Sector horn antenna
- c. Micro-strip patch antenna
- d. Microwave dipole antenna

158. What is a waveguide device which is designed with steps in either the magnetic or electric plane known as?

- a. Conductance converter
- b. Impedance transformer
- c. Impedance canceller
- d. Reactance follower

159. Which principle of operation of cavity wave meters is used in microwave networks?

- a. Phase shift
- b. Resonance
- c. Polarization shift
- d. Gyration

160. In a waveguide network, there is a component which consists of an E-plane Tee combined with an H-plane Tee. What is this component generally known as?

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- a. Directional Tee b. Phased array Tee
c. Coupler Tee d. Magic Tee

161. Phase focusing, which leads to bunching of electrons takes place in which one of the following?

- a. Double resonator klystron
b. Reflex klystron
c. TWT
d. Magnetron

162. In a magnetron oscillator, the improvement of stability and efficiency is achieved by which technique?

- a. Strapping b. Cross coupling
c. Bunching d. Bouncing

163. A Gunn diode is a negative resistance device. Which is used as source of microwaves. What is the number of p-n junctions?

- a. 1 b. 2
c. 3 d. 0

164. In a TWT the helix is used as which one of the following/

- a. Slow wave structure
b. Fast wave structure
c. Amplifying element
d. Attenuating element

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Microwave Engineering OLD IES Questions



ANSWERS & SOLUTIONS

1. (a)
2. (a)

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- 3. (c)
- 4. (c)
- 5. (c)
- 6. (c)
- 7. (d)
- 8. (b)
- 9. (b)
- 10. (c)
- 11. (c)

$$\lambda f = \frac{c}{\sqrt{\epsilon_r}}$$

$$12 \times 10^{-3} \times 10 \times 10^9 = \frac{3 \times 10^8}{\sqrt{\epsilon_r}}$$

$$\Rightarrow \sqrt{\epsilon_r} = 2.5$$

$$\Rightarrow \epsilon_r = 6.25$$

- 12. (c)
- 13. (a)
- 14. (b)

Total attenuation

$$= 20 \log \frac{1000}{10^{-3}}$$

$$= 120 \text{ dB}$$

Maximum link length,

$$L_{max} = \frac{120}{1} \times 100 \text{ m}$$

$$L_{max} = 12 \text{ Km}$$

- 15. (d)

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16. (a)

17. (a)

18.(a)

Resonant frequency

$$f_0 = \text{Quality factor} \times \text{Bandwidth}$$

$$f_0 = 4000 \times 2.4 \times 10^6$$

$$f_0 = 9.6 \text{ GHz}$$

19. (a)

20. (d)

Drift velocity of electron,

$$V_d = 10^7 \text{ cm/s}$$

Active region length

$$L = 10 \times 10^{-4} \text{ cm}$$

Natural frequency of oscillation.

$$f = \frac{v_d}{L} = \frac{10^7}{10 \times 10^{-4}}$$

$$f = 10 \text{ GHz}$$

21. (c)

Varactor diodes have most common applications in tuning, in microwave multipliers and in the very low-noise microwave parametric amplifiers.

22. (b)

23. (d)

24. (a)

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Cut off frequency of rectangular wave guide.

$$f_c = \frac{c}{2} \sqrt{\left(\frac{m}{a}\right)^2 + \left(\frac{n}{b}\right)^2}$$

Narrow dimension $b \downarrow = f_c \downarrow$

Wave impedance for TE mode in rectangular waveguide.

$$Z_{TE} = \frac{\eta}{\sqrt{1 - \left(\frac{f_c}{f}\right)^2}}$$

$$f_c \uparrow = Z_{TE} \uparrow$$

Attenuation in rectangular wave guide for TE mode is

$$\alpha_g = \frac{\alpha \eta}{2 \sqrt{1 - \left(\frac{f_c}{f}\right)^2}}$$

$$f_c \uparrow = \alpha_g \uparrow$$

Guided wavelength in rectangular wave guide for TE mode

$$\lambda_g = \frac{\lambda}{\sqrt{1 - \left(\frac{f_c}{f}\right)^2}}$$

$$f_c \uparrow = \lambda_g \uparrow$$

25. (c)

Characteristics impedance of quarter wave transformer is

$$\begin{aligned} Z_0 &= \sqrt{Z_s Z_L} \\ &= \sqrt{75 \times 300} \\ &= 150 \Omega \end{aligned}$$

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26. (c)

(i) Quality factor

$$Q = \frac{2 \pi \times \text{maximum energy stored}}{\text{Energy dissipated per cycle}}$$

(ii) The cut-off frequency in TEM mode in a lossless medium is zero.

(iii) Dominant mode of cylindrical waveguide is TE_{11} .

(iv) $\beta = \omega/v_p$

27. (d)

Radiation resistance,

$$R_{\text{rad}} = 60 \Omega$$

Antenna resistance,

$$R_{\text{ant}} = 40 \Omega$$

Efficiency of the antenna

$$\eta = \frac{R_{\text{rad}}}{R_{\text{rad}} + R_{\text{ant}}} \times 100$$

$$\eta = \frac{60}{60+40} \times 100$$

$$\eta = 60 \%$$

28. (c)

29. (b)

$$10 \log \frac{P_1}{0.1 \times 10^{-3}} = 40$$

Where, P_1 = Power at the input of DUT

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$$P_1 = 0.1 \times 10^{-3} \times 10^4 = 1 \text{ W}$$



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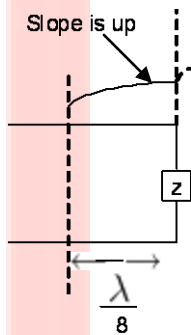
$$10 \log \frac{P_2}{0.01 \times 10^{-3}} = 30$$

Where, P_2 = Power at the output of DUT

$$P_2 = 0.01 \times 10^{-3} \times 10^{-3} = 10^{-2} \text{ W}$$

$$\begin{aligned} \text{Insertion loss} &= 10 \log \frac{P_1}{P_2} \\ &= 10 \log \frac{1}{10^{-2}} \\ &= 10 \log 100 \\ &= 20 \text{ dB} \end{aligned}$$

30. (a)



If the standing wave of voltage slopes down the terminating impedance, the impedance is inductive. If the slope is up toward the impedance, the impedance is capacitive

31. (b)

$$\begin{aligned} \text{Duty cycle} &= \frac{\text{Average Power}}{\text{Peak Power}} \times 100 \\ &= 800 \end{aligned}$$

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$$\overline{10^4} \times 100$$

$$= 8 \%$$

32. (a)

$$B_2 = 2B_1 \text{ and } (\text{SNR})_1 = 30 \text{ dB}$$

$$B_1 (\text{SNR})_1 = B_2 (\text{SNR})_2$$

$$(\text{SNR})_2 = B_1/B_2 \times (\text{SNR})_1$$

$$= \frac{1}{2} \times (\text{SNR})_1$$

$$10 \log (\text{SNR})_2 = -10 \log 2 + 10 \log (\text{SNR})_1$$

$$(\text{SNR})_2 \text{ (dB)} = -3 + (\text{SNR})_1 \text{ (dB)}$$

$$(\text{SNR})_2 \text{ (dB)} = -3 + 30 = 27 \text{ dB}$$

33. (b)

Phase constant

$$\beta = \frac{\omega}{v_p}$$

$$v_p = \frac{c}{\sqrt{\epsilon_r}}$$

So the change of phase depends upon

- (i) permeability of the media
- (ii) frequency of wave
- (iii) velocity of wave

34. (d)

35. (c)

36. (c)

37. (d)

Wave length,

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$$\lambda = \frac{3 \times 10^8}{10 \times 10^9} = \frac{3}{100} \text{ m}$$

For accurate far field pattern distance

$$r \geq \frac{2D^2}{\lambda}$$

Where D = Diameter of parabolic reflector antenna

$$r \geq \frac{2 \times (3)^2 \times 100}{3}$$

$$r \geq 600 \text{ m}$$

Therefore, minimum distance,

$$r_{\min} = 600 \text{ m}$$

38. (c)

In LSA mode, the domains do not have sufficient time to form while field is above threshold. As a result most of the domains are maintained in the negative conductance state during a large fraction of the voltage cycle.

39. (b)

(i) Step-recovery diodes are used without a tuned output circuit, to produce multiple harmonics in so-called “comb generators”.

(ii) MESFETs are very commonly used in microwave integrated circuits for high power low noise, and broadband amplifier applications.

(iii) PIN diodes are widely used for microwave power switching limiting and modulation.

40. (c)

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CFA uses TWT structure to provide an interaction between crossed d.c. electric and magnetic field on one hand and RF fields on the other hands,

41. (a)

At higher frequencies, the shunt capacitances become almost a short which cannot be neglected. Therefore, broad banding a microwave transistor RF amplifier is difficult because of shunt capacitance loading-effect.

42. (a)

The dominant mode TE_{10} in a rectangular waveguide will excite the dominant mode TE_{11} in a circular waveguide.

43. (a)

Helical antenna produces circularly polarized beams in microwave communication fields.

44. (c)

When an electromagnetic wave is incident parallel to the axis. It passes through the focus point of spherical reflector.

45.(d)

TE_{111} mode is dominant in cylindrical cavity if $d \geq 2a$.

Where, d = length of the resonator.

a = radius of the cavity resonator

TM_{10} mode is dominant where $2a > d$. The lowest frequency band for microwave frequencies is X-band.

46. (c)

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47. (b)

In parametric amplifier the power gain is defined as a ratio of the power delivered by the capacitor at a frequency of $f_p + f_s$ to that absorbed by the capacitor at a frequency of f_s .

$$\text{Gain} = \frac{f_p + f_s}{f_s}$$

where, f_p = Pump frequency

f_s = Signal frequency

Thus, gain is mainly restricted by pump frequency

48. (a)

49. (c)

Power at port 2,

$$P_2 = 10 \text{ mW}$$

Power at port 3,

$$P_3 = \frac{10 \times 10^{-3}}{100} \\ = 10^{-4} \text{ W}$$

Power at port 4,

$$P_4 = 0.01 \times 10^{-6} \text{ W}$$

Directivity (dB) = $10 \log P_4/P_3$

$$= 10 \log \frac{0.01 \times 10^{-6}}{10^{-4}}$$

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$$10^{-4}$$

$$= -40 \text{ dB}$$

Numerical value of directivity = 40 dB

50. (a)

51. (c)

52. (c)

Gunn diode is fabricated from compound semiconductors such as GaAs.

GaAs has lesser frequency stability than silicon as it shows the periodic fluctuations of current passing through the GaAs specimen when the applied voltage exceeds a certain critical value (2-4 V/cm).

53. (a)

54. (a)

Drift velocity,

$$V_d = 10^5 \text{ m/s}$$

Drift length

$$L = 4 \mu \text{ m}$$

Operating frequency of IMPATTI diode

$$f = \frac{v_d}{L}$$
$$= \frac{10^5}{4 \times 10^{-6}} = 25 \text{ GHz}$$

55. (b)

56. (c)

57. (a)

58. (d)

59. (d)

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$$a = 4.5 \text{ cm}$$

Cut off wavelength for TE_{10} mode is

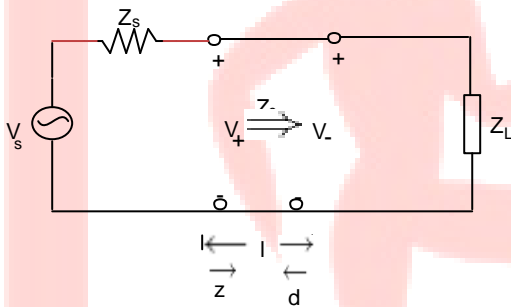
$$\lambda_c = 2a$$

$$= 2 \times 4.5 = 9 \text{ cm}$$

60. (a)

In circular waveguide, second suffix of TE or TM mode can never be zero.

61. (d)



Reflection coefficient at the receiving end is

$$\rho_l = \frac{Z_L - Z_0}{Z_L + Z_0}$$

The reflection coefficient at some point located at distance d from the receiving end is

$$\rho_d = |\rho_l| e^{-2\alpha d} e^{j(\theta_l - 2\beta d)}$$

where, α = attenuation constant

β = phase constant

62. (a)

$f \uparrow = \text{Bandwidth} \uparrow$

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$f \uparrow = \lambda \downarrow = \text{Size of component} \downarrow$

$f \uparrow = \text{Interference} \downarrow$

63. (a)

$$V_{SWR} = \frac{|V_{max}|}{|V_{min}|} = \frac{64}{16} = 4$$

64. (a)

65. (d)

Helical antenna is circularly polarized.

66. (c)

The imaginary part of a complex permittivity is a measure of losses in the material.

67. (b)

68. (c)

Critical voltage,

$$\begin{aligned} V &= Ed \\ &= 3.2 \times 10^3 \times 10 \times 10^{-4} \\ &= 3.2 \text{ V} \end{aligned}$$

69. (b)

70. (c)

71. (d)

Other are used as oscillators.

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72. (c)

The cut off wavelength of a dominant mode in a rectangular wave guide depends only on its width, not on height.

73. (a)

The dominant mode of a rectangular waveguide is TE_{10} .

74. (b)

75. (b)

76. (b)

77. (a)

Typical f/D ratio in practice for a paraboloid reflector is between 0.2 to 0.5

78. (c)

Maximum possible gain

$$\begin{aligned} &= \pi^2 \left(\frac{D}{\lambda} \right)^2 \\ &= (3.14) \left(\frac{1}{3.14 \times 10^{-2}} \right)^2 \\ &= 10^4 \end{aligned}$$

Maximum possible gain (dB)

$$\begin{aligned} &= 10 \log 10^4 \\ &= 40 \text{ dB} \end{aligned}$$

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79. (c)

80. (b)

Due to 3-dB coupler placed before the load. The power to the load will be halved.

$$10 \log \alpha = 3$$

$$\alpha = (10)^{3/10}$$

$$\alpha = 2$$

where α is the attenuation
power to the load

$$= \frac{50 \text{ mW}}{2}$$

$$= 25 \text{ mW}$$

81. (d)

82. (c)

83. (a)

Helical antenna is used for circular polarization.

84. (c)

85. (a)

Effective earth radius is $4/3$ times the actual earth radius.

86. (a)

87. (c)

Designation	Frequency range (in GHz)

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HF	0.003-0.030
VHF	0.030-0.300
UHF	0.300-1.000
L band	1-2
S band	2-4
C band	4-8
X band	8-12
Ku band	12-18
K band	18-27
Ka band	27-40
Millimeter	40-300
Sub millimeter	> 300

88. (c)

89. (d)

90. (a)

91. (c)

Drift velocity

$$V_d = 10^7 \text{ cm/s}$$

Active region length

$$L = 10^3 \text{ cm}$$

Natural frequency of oscillation,

$$f = \frac{v_d}{L} = \frac{10^7}{10^{-3}} = 10 \text{ GHz}$$

92. (a)

93. (b)

At the output, there will be dominant mode in circular waveguide, i.e. TE₁₁ mode.

94. (b)

95. (d)

96. (b)

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Microwave Engineering OLD IES Questions

Cutoff wavelength of TM_{11} mode in circular waveguide.

$$\lambda_c = \frac{\pi D}{3.83}$$

$$\lambda_c = 0.82 D$$

97. (d)

$$\begin{aligned} VSWR &= \frac{Z_L}{Z_0} \\ &= \frac{72}{50} \\ &= 1.44 \end{aligned}$$

98. (c)

99. (d)

100. (c)

101. (a)

102. (c)

103. (a)

Microstrip antennas are useful for microwave and millimeter wave applications where low cost, low profile conformability and ease of manufacture are found to overcome the disadvantage such as narrow bandwidth and low power capacity. The quality factor of microstrip lines is very high.

104. (b)

105. (c)

106. (c)

107. (b)

108. (c)

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109. (b)

Required distance

$$\begin{aligned} &= \frac{2D^2}{\lambda} \\ &= \frac{2D^2 f}{c} \\ &= \frac{2 \times 5^2 \times 6 \times 10^9}{3 \times 10^8} \\ &= 1 \text{ Km} \end{aligned}$$

110.(a)

$$\begin{aligned} |\rho| &= \left| \frac{Z_L - Z_0}{Z_L + Z_0} \right| \\ &= \left| \frac{40 + j30 - 50}{40 + j30 + 50} \right| \\ &= \left| \frac{-10 + j30}{90 + j30} \right| \\ &= \frac{\sqrt{(-10)^2 + (30)^2}}{\sqrt{(90)^2 + (30)^2}} \\ &= \frac{\sqrt{1000}}{\sqrt{9000}} \\ &= \frac{1}{3} \end{aligned}$$

$$VSWR = \frac{1 + |\rho|}{1 - |\rho|}$$

$$\begin{aligned} &= \frac{1 + \frac{1}{3}}{1 - \frac{1}{3}} \\ &= \frac{4}{2} \end{aligned}$$

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= 2

111. (c)

The lowest order TM mode will be TM_{11} .

So,

$$E_z = 20 \sin\left(\frac{60}{3}\right) \sin\left(\frac{100\pi y}{2}\right)$$
$$= 20 \sin(20\pi x) \sin(50\pi y)$$

112. (c)

Cut off frequency for TE_{10} mode is

$$f_c = \frac{3 \times 10^{10}}{2} \sqrt{\left(\frac{1}{a\sqrt{3}}\right)^2 + 0}$$

= 2 GHz

$$\Rightarrow \frac{3 \times 10^{10}}{2\sqrt{3}a} = 2 \times 10^9$$

$$\Rightarrow a = \frac{10\sqrt{3}}{4} = \frac{5\sqrt{3}}{2} \text{ cm}$$

Cut off frequency for TM_{11} mode is

$$f_c = \frac{3 \times 10^{10}}{2} \sqrt{\left(\frac{1}{a\sqrt{3}}\right)^2 + \left(\frac{1}{a}\right)^2}$$

$$= \frac{3 \times 10^{10}}{2} \cdot \frac{2}{a\sqrt{3}}$$

$$= \frac{3 \times 10^{10} \times 2}{5\sqrt{3} \cdot \sqrt{3}}$$

= 4 GHz

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113. (a)

The lowest mode excited in the circular waveguide is TE_1 .

114. (c)

115. (a)

116. (b)

117. (b)

118. (d)

119. (d)

120. (c)

In parametric amplifiers, the pump energy is the deciding factor for amplification factor.

121. (a)

TWT is a wide-band device.

122. (d)

123. (a)

124. (b)

125. (b)

126. (c)

127. (b)

Attenuator is used in TWT to prevent oscillations.

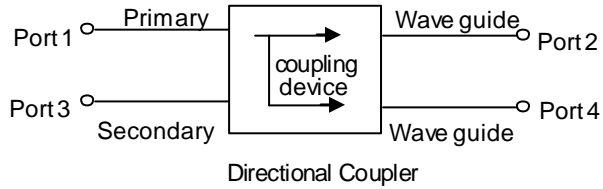
128. (b)

129. (d)

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$$\text{Coupling factor (dB)} = 10 \log_{10} \frac{P_1}{P_4}$$

$$\text{Directive (dB)} = 10 \log_{10} \frac{P_4}{P_3}$$

130. (b)

Phase velocity

$$v_p = \frac{c}{\sqrt{\epsilon_e}}$$

131. (c)

Microstrip lines are operated under the condition where the substrate thickness is much less than the free-space wavelength

132. ()

133. (d)

134. (a)

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135. (c)

Designation	Frequency range (in GHz)
HF	0.003-0.030
VHF	0.030-0.300
UHF	0.300-1.000
L band	1-2
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X band	8-12
Ku band	12-18
K band	18-27
Ka band	27-40
Millimeter	40-300
Sub millimeter	> 300

136. (d)

- (i) Surface wave travels along earth crust.
- (ii) Sky wave travels in ionosphere.
- (iii) Space wave travels in troposphere.
- (iv) Microstrip line is used for guided wave.

137. (b)

- (i) LSA mode is one of the four modes of operation of Gunn diode.
- (ii) Bunching occurs in klystron amplifier.
- (iii) Up-converter is the type of parametric amplifier where output frequency is the sum of pump frequency and signal frequency
- (iv) The basic physical mechanism of the IMPATT diode is the interaction of the impact ionization avalanche and the transit time of charge carriers.

138. (a)

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In IWT, the applied signal propagates around the turns of the helix and produces an electric field at the centre of the helix, directed along the helix axis.

139. (d)

140. (c)

The reflex klystron is a single-cavity klystron which provides low power output of 10 to 500 mW with highly stable single frequency in the range of 1 to 25 GHz.

141. (d)

142. (d)

143. (c)

Microstrip line has three types of losses, to dielectric, ohmic and radiation losses.

144. (c)

Wave guide twist is helpful in converting vertical to horizontal polarization of vice versa.

145. (a)

Cut-off frequency

$$f_0 = \frac{c}{2\sqrt{\epsilon_r}a}$$
$$= \frac{3 \times 10^8}{2\sqrt{4} \times 1.5 \times 10^{-2}}$$

Therefore the 8 GHz signal will pass through the wave guide.

146. (a)

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$$\begin{aligned}\text{Phase difference} &= \frac{2\pi}{\pi} (\text{Path difference}) \\ &= \frac{2\pi f}{c} (\text{Path difference}) \\ &= \frac{2\pi \times 10 \times 10^9}{3 \times 10^8} (3 \times 10^{-2})\end{aligned}$$

147. (a)

$$\begin{aligned}\lambda &= \frac{v}{f} \\ &= \frac{c}{\sqrt{\epsilon_r} f} \left(\because \frac{c}{\sqrt{\epsilon_r}} \right) \\ &= \frac{c}{n f}\end{aligned}$$

148. (a)

149. (d)

$$\begin{aligned}\text{Gain (dB)} &= 10 \log_{10} 200 \\ &= 10 (\log_{10} 2 + \log_{10} 100) \\ &= 10 (0.30 + 2) \\ &= 23 \text{ dB}\end{aligned}$$

150. (c)

Microwave frequencies range from 1 GHz to 1000 GHz. Therefore, bandwidth of the order of 12 MHz can be realized easily using carriers in microwave range.

151. (a)

152. (b)

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The isolator is very desirable in a microwave circuit to match a source with a variable load. Thus the main purpose of inserting a microwave insulator for offering maximum power output from the source.

153. (a)

Absorption cavities attenuate the signal frequency to which they are tuned.

154. (b)

155. (b)

Pulse duration $\tau = 1.5 \mu\text{s}$

PRF = $f_p = 1 \text{ KHz}$

Average signal power

$$\begin{aligned} P_{av} &= \frac{15 \times 10^{-3}}{\tau f_p} \\ &= \frac{15 \times 10^{-3}}{1.5 \times 10^{-6} \times 10^3} \\ &= 10 \text{ W} \end{aligned}$$

156. (b)

Helical antenna is a broadband VHF or UHF antenna to provide circular polarization.

157. (c)

158. ()

159. (b)

160. (d)

161. (d)

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162.(a)

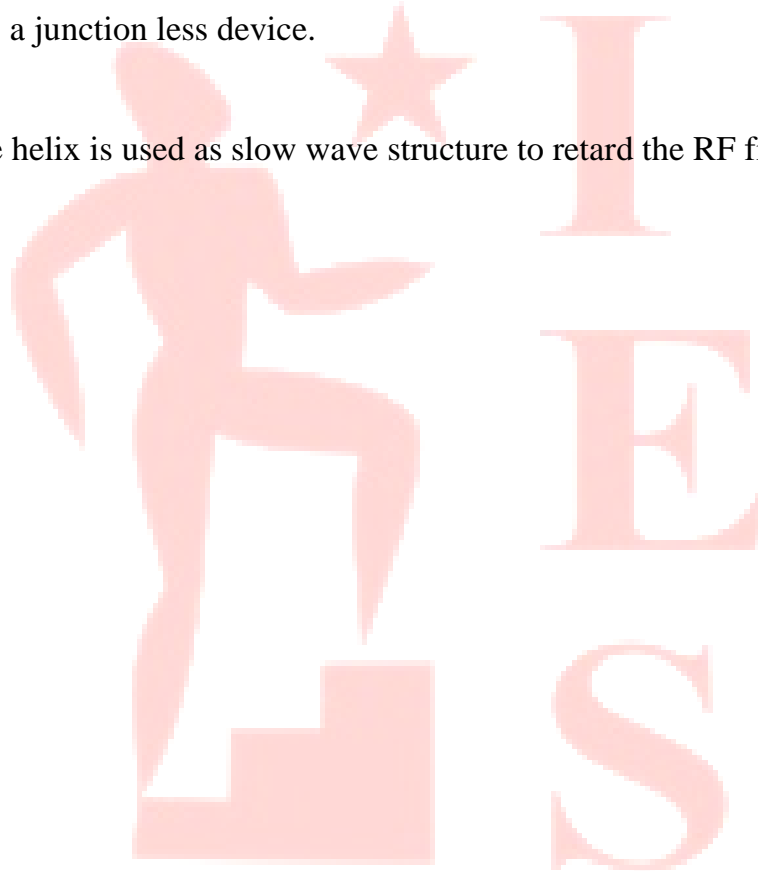
Strapping means to connect alternate anode plates with two conducting rings of heavy gauge touching the anode's pole. This is done in order to make the 2π anode poles together (0.2π and 6π anode cavities). Strap helps in achieving only the dominant mode in the magnetron.

163. (d)

Gunn diode is a junction less device.

164. (a)

In a TWT, the helix is used as slow wave structure to retard the RF field.



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