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Total number of printed pages – 4

B. Tech
PCEC 4402

Eighth Semester Regular Examination – 2015

MICROWAVE ENGINEERING

BRANCH (S) : EC, ETC

QUESTION CODE : J 110

Full Marks – 70

Time : 3 Hours

Answer Question No. 1 which is compulsory and any five from the rest.

The figures in the right-hand margin indicate marks.



1. Answer the following questions :

2×10

- A lossless 100Ω transmission line is terminated in $50 + j75$. Find voltage reflection co-efficient and VSWR.
- Define stub. What is the significance of stub length in transmission line ?
- What is the input impedance of terminated transmission line for short circuited and open circuited line ?
- Calculate the characteristic impedance and propagation constant for a lossless co-axial line having inner radius 0.3 mm and outer radius 0.6 mm with $\mu_r = 2.3$ and $\epsilon_r = 1.4$ at operating frequency 5 MHz.
- Differentiate between the reciprocal and non-reciprocal devices.
- What is LSA oscillation mode of Gunn diode ?
- What is rat-race hybrid coupler ? Write down the scattering matrix of this coupler.
- A rectangular cavity resonator made of copper has dimensions $a = 3$ cm, $b = 1$ cm, $c = 4$ cm filled with dielectric $\epsilon_r = 2.56$, and operates at the dominant mode. Determine the resonant frequency.

P.T.O.

- (i) For which condition a Klystron amplifier act as oscillator ? Write two applications of Klystron amplifier.
- (j) What is the bunching parameter of reflex klystron oscillator ?
2. (a) A uniform transmission line has $R=12 \text{ m}\Omega/\text{m}$, $G=1.4 \mu\text{mho}/\text{m}$, $L=1.5 \mu\text{H}/\text{m}$ and $C=1.4 \text{ nF}/\text{m}$. At 70 kHz find (i) characteristic impedance, (ii) attenuation in decibels per kilometer, (iii) the velocity of propagation and (iv) propagation constant. 4
- (b) The characteristic impedance of a 10 m long lossless co-axial cable is 50Ω . The dielectric material between the inner and outer conductors of the cable has $\epsilon_r = 3.5$ and $\mu_r = 1$. If the radius of the inner conductor is 1 mm, what should be the outer radius of this cable ? 3
- (c) For sea water $\sigma = 4 \text{ S}/\text{m}$ and $\epsilon_r = 80$, $\mu_r = 1$. Calculate, the attenuation constant (α) and propagation constant (γ) at frequencies 1 kHz, 100 kHz and 1000 kHz and also find the skin depth (δ_c) at 100 kHz. 3
3. (a) A 50Ω transmission line is terminated on a load of $100 + j70 \Omega$. Using Smith chart find (i) reflection co-efficient, (ii) transmission co-efficient, (iii) VSWR, (iv) input impedance at a distance of 0.3λ from load, (v) distance of the first minimum from the load. 6
- (b) Referring to the Figure 1 below, two loads $R_1 = 300 \Omega$, $R_2 = 200 \Omega$ are to be fed in phase from a 100Ω line with R_1 receiving twice the power of R_2 . Calculate (i) L_1 and Z_1 , (ii) L_2 and Z_2 using $\lambda/4$ matching condition. 4

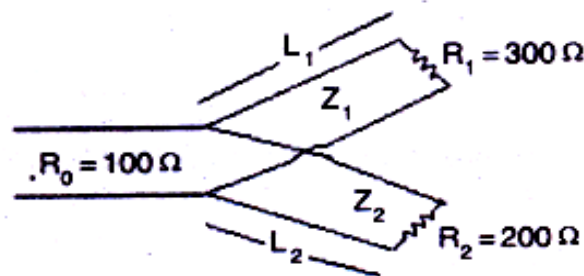


Figure 1: Power Splitter

4. (a) A rectangular wave guide with $a = 2.1$ cm and $b = 3.2$ cm is filled with a dielectric of $\epsilon_r = 3.21$ and is operated at 50 GHz. Calculate the (i) cut-off frequency, (ii) wavelength, (iii) phase constant, (iv) phase velocity, (v) group velocity and (vi) wave impedance for TE_{22} mode. 4
- (b) A rectangular waveguide has dimensions 4 cm \times 2 cm. Assuming TE mode of operation good conductivity of walls and air as dielectric, if the waveguide is operated at a frequency 20% higher than the cut-off frequency, calculate, (i) the mode, (ii) the guide wavelength, (iii) phase velocity and (iv) the group velocity. 4
- (c) A plane electromagnetic wave is incident on a material having $\epsilon_r = 2.34$. Calculate the reflection co-efficient and the VSWR. 2
5. (a) Write down the scattering matrix for directional coupler with proper conditions. Find out the transmission loss. 5
- (b) Explain the design procedure of microwave filter by using image parameter method. 5
6. (a) Explain the velocity modulation process in reflex klystron with neat diagram. And derive the expression for depth of velocity modulation. 6
- (b) A Reflex Klystron operates under the following conditions :
- $V_0 = 500$ V, $R_{sh} = 20$ k Ω , $f_r = 8$ GHz and $L = 1$ mm is the spacing between repeller and cavity. The tube is oscillating at f_r at the peak of $n = 2$ mode. Assume that the transit time through the gap and beam loading effect can be neglected. Find (i) the repeller voltage V_r , (ii) direct current necessary to give microwave gap voltage of 200 V and (iii) electronic efficiency. 4



7. (a) A 250 KW pulsed cylindrical magnetron is operated with the following parameters :

anode voltage = 25 KV,

peak anode current = 25 A,

magnetic induction = 0.035 T,

radius of cathode = 4.0 cm, and

radius of anode = 8.0 cm.

Calculate (i) the efficiency of magnetron, (ii) the cyclotron frequency, (iii) the cut-off magnetic field and (iv) the cut-off voltage. 6

- (b) Explain the hazards of electromagnetic radiation. 4

8. Write short notes on any **two** : 5×2

- (a) Principle of operation of TWT amplifier
- (b) Gunn Oscillation modes
- (c) Wilkinson Power Divider
- (d) Fixed and Variable Attenuator. .

