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Question Paper Code : 50967

B.E./B.Tech. DEGREE EXAMINATIONS, APRIL/MAY 2024.

Fifth Semester

Electronics and Communication Engineering

EC 3551 – TRANSMISSION LINES AND RF SYSTEMS

(Common to : Electronics and Telecommunication Engineering)

(Regulations 2021)

Time : Three hours Maximum : 100 marks

(Note : Smith chart can be provided on request)

Answer ALL questions.

PART A — (10 × 2 = 20 marks)

1. Justify that a finite line terminated in its characteristic impedance behaves as an infinite line.

2. Find the input impedance of a transmission line of length $\lambda/8$, terminated with the load impedance of $40 + j20\,\Omega$. Assume $Z_0 = 50\,\Omega$.

3. What are Standing waves? When the standing wave does exists?

4. An lossless line has a characteristic impedance of $400\,\Omega$. Find the standing wave ratio with the receiving end impedance of $Z_R = 70 + j0.0\,\Omega$.

5. What is the significance of quarter wave line? Recall the equation for the input impedance?

6. Mention any two applications of smith chart.

7. Sketch the variation of attenuation with frequency for TE, TM and TEM waves.

8. Define TE, TM mode of propagation.

9. Define skin depth.

10. List the characteristic parameters of power amplifier.

PART B — (5 × 13 = 65 marks)

11. (a) (i) Determine secondary constants for a transmission line with the following primary constants: R = 100 Ω/km, G = 15×10^{-6} mho/km, $L = 0.001\,\mu H$ / Km , $C = 0.062\,\mu F$ / Km . (6)

(ii) Discuss the two types of waveform distortion on a transmission line and obtain the condition for the distortionless line. (7)

Or

(b) Derive the expression to determine current and voltage at any point along a transmission line of length 'l', terminated with Z_0. (13)

12. (a) (i) A transmission line with a characteristic impedance of $Z_0 = 820 \angle -34^\circ$ is terminated with Z_R = 100 ohm. Calculate VSWR, Reflection loss in dB and reflection coefficient. (6)

(ii) Interpret the method to measure VSWR and wavelength in a transmission line. (7)

Or

(b) (i) Determine the reflection coefficient, VSWR, and input impedance for a transmission line terminated with matched, short-circuited, and open- circuited loads. (7)

(ii) Derive the relation between a transmission line's standing wave ratio and reflection coefficient. (6)

13. (a) Using Smith chart, determine the following for a 50 Ω lossless transmission, terminated with the load of 20+j30 Ω, phase velocity = 0.5 c and frequency = 900 MHz, where *c* is the free space velocity.

(i) Input impedance at a distance of 5 cm from the load (3)

(ii) Input reflection coefficient at the same distance above (3)

(iii) VSWR (3)

(iv) Input and Load admittance (4)

Or

(b) Summarize the role of the Quarter wave transformer in the electric signal distribution. Also, determine the length and impedance of a quarter wave transformer that will match a 150 Ω load to a 75 Ω line at a frequency of 12 GHz. (13)

14. (a) (i) Derive the general field components of TM_{mm} waves in waveguides. (7)

(ii) Justify and explain that "TEM mode does not exist in a rectangular waveguide." (6)

Or

(b) (i) Define attenuation and prove that the frequency of minimum attenuation due to conductor loss in a parallel plate waveguide for TM waves is $\sqrt{3}\, f_c$. (7)

(ii) A resonator is filled with air with dimensions a = 4 cm, b = 3 cm, and c = 10 cm with $\sigma_c = 5.8$. Find the resonant frequency f_r and the Quality Factor, Q, of TE_{101} mode. (6)

15. (a) Summarize the steps in designing a single-stage RF amplifier with constant gain. (13)

Or

(b) Discuss the significance of filters, couplers, low-noise amplifiers and power amplifiers in the context of RF systems. (13)

PART C — (1 × 15 = 15 marks)

16. (a) An RF transmission line with a characteristic impedance of $300 \angle 0^\circ \Omega$ terminated in an impedance of $100 \angle 45^\circ \Omega$. This load will be matched to the transmission line using a short-circuited stub. With the help of a Smith chart, determine the stub's length and its distance from the load.

Or

(b) Obtain an expression for TE waves between parallel plates. Sketch the field distribution for electric and magnetic fields for TE_{10} mode between parallel planes.