

B.E.Tel.E. 2nd YEAR EXAMINATION, 2023
(2nd Semester)

TRANSMISSION LINES AND WAVEGUIDES

Time: Three hours

Full Marks 100

No. of
questions

Marks

Answer any *five* questions.

Consider $\epsilon_0=8.854 \times 10^{-12}$ F/m and $\mu_0=4\pi \times 10^{-7}$ H/m

Values of other universal physical constants may be assumed, if necessary.

Usage of Smith Chart is permitted.

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| 1.(a) | Consider a lossless coaxial air line with inner conductor radius 'a' and outer conductor radius 'b'. The outer conductor is grounded while the inner conductor is raised to a voltage V_0 . Derive appropriate expressions for electric and magnetic fields along it and plot them to justify that the mode of propagation is TEM. | 12 |
| (b) | Therefrom obtain its characteristic impedance. | 8 |
| 2.(a) | Establish the condition to be met by a distortionless line | 10 |
| (b) | Derive Campbell's equation to solve for the propagation constant along a line with lumped inductive loading. | 10 |
| 3. | A generator of 1V, 1kHz supplies power to a 100 km open wire line terminated in Z_0 . The line parameters are
$R=10.4 \Omega/\text{km}$, $L=0.00367 \text{ h/km}$, $G=0.8 \times 10^{-6} \text{ S/km}$ & $C=0.00835 \mu\text{f/km}$.
Calculate
Received current
Received voltage and
Power delivered | 4X3 |
| (b) | Write a note on Reflection Loss. | 8 |
| 4.(a) | A transmission line is terminated in Z_L . Measurements indicate that the standing wave minima are 102cm apart and that the last minimum is 35 cm distant from the load end of the line. The value of VSWR is measured to be 2.4 and $R_0=250\Omega$.
Find Z_L in both rectangular and polar forms. | 12 |
| (b) | A certain line of $R_0=400\Omega$ is $(7/16)\lambda$ long and open at both ends. Find the impedance seen by a generator connected at a point distant $\lambda/4$ from one end. | 8 |
| 5.(a) | Design a quarter wave matching section to match a 100Ω load to a 50Ω line at 300 MHz elaborating the design theory. | 8 |
| (b) | What would happen if the frequency is changed to 600 MHz? | 2 |
| (c) | Also determine its band width if a maximum reflection coefficient of 3% can be tolerated within the useful frequency range. | 10 |
| 6.(a) | Discuss how the Smith chart grid is plotted. | 8 |
| (b) | Why is it that the same Smith chart may be used both for impedance and admittance computations? | 4 |
| (c) | Assume that a line has VSWR=2.5 and it is found that a voltage minimum exists at 0.15λ from the load. Find the load and source impedances for a line of 0.35λ length. | 8 |

[Turn over

- 7.(a) Establish the filtering nature of a rectangular waveguide by solving Helmholtz equation in its context. 10
- (b) Why would you not use C band waveguide to propagate a K band signal? 2
- (c) Work out the cutoff frequency of TM_{11} mode in a waveguide of cross sectional dimensions $a \times b$. 8
- 8.(a) With neat sketches show the approximate distribution of electric and magnetic fields in stripline, microstrip and coplanar waveguide. 4X3
- (b) Of the three, which is most ideally suited for both series and shunt mounting of components? 2
- (c) Prove that microstrip cannot support pure TEM mode. 6