Ref. No: Ex/ET/PC/B/T/224/2022

B.E.Tel.E. 2nd YEAR EXAMINATION, 2022
(2nd Semester)

TRANSMISSION LINES AND WAVEGUIDES

Time: Three hours | Full Marks 100

No. of questions		Marks

Answer any *five* questions.
Consider $\varepsilon_0=8.854X10^{-12}$F/m and $\mu_0=4\pi X10^{-7}$H/m
Values of other universal physical constants may be assumed, if necessary.
Usage of Smith Chart is permitted.

1.(a)	Consider a lossless coaxial air line with inner conductor radius 'a' and outer conductor radius 'b'. Calculate its series inductance per unit length and shunt capacitance per unit length	8+8
(b)	Hence calculate its characteristic impedance	4
2.(a)	Prove that the image propagation constant of a symmetric two port lumped network with length ds reduces to $\sqrt{(Z/Y)}$ as ds$\rightarrow$0 in limit where Z is its series impedance per unit length and Y is its shunt admittance per unit length.	10
(b)	Discuss the significance of this result with respect to an infinite transmission line with physical justification(s).	10
3.	A generator of 1V, 1kHz supplies power to a 100 km open wire line terminated in a 200 Ω resistance. The line parameters are R=19.4 Ω/km, L=0.00367 h/km, G=$9.8X10^{-4}$ S/km & C=0.00835 μf/km. Calculate	
(a)	The input current	6
(b)	Received current	6
(c)	Power delivered and	4
(d)	Efficiency of the system	4
4.(a)	Plot the voltage and current standing waves against distance for an RF cable for the following terminations, in each case writing their analytical expressions as well as the value of VSWR Open circuit, short circuit, matched load, $R_R=3R_0$ and $R_R=R_0/3$	5X3
(b)	Determine the length of a 330Ω open circuited dissipationless line required to produce an inductance of 7μh at 75MHz.	5
5.(a)	Design a quarter wave transformer to match a 100Ω load to a 50Ω line at 1GHz.	6
(b)	Also determine its band width if a maximum reflection coefficient of 2% can be tolerated within the useful frequency range.	8
(c)	Define the terms Characteristic Impedance, Intrinsic Impedance and Wave Impedance with proper reference to their contexts,	3X2
6.(a)	Consider three lossless cables (each operating at 700 MHz with phase velocity $2.1X10^8$ m/sec) as follow Cable1: Z_0=70Ω, length=43.5 cm terminated by j70Ω; Cable2: Z_0=90Ω, length=21 cm terminated by 40Ω; Cable3: Z_0=50Ω, length=1.25 m terminated by the shunt combination of Cable1 and Cable2. Find input impedance of Cable3 and VSWR along it.	6+4

(b)	Determine the electrical length and location of a short circuited shunt stub to match a (100+j120)Ω load to a 50Ω line	10
7.(a)	Prove that a rectangular waveguide is a high pass filter.	8
(b)	Justify that a waveguide cannot support pure TEM mode.	4
(c)	Why are different waveguides used for different microwave frequency bands?	4
(d)	What is the cutoff frequency of a WR90 waveguide, whose inner cross sectional dimensions are 0.9″X0.4″?	2
(e)	For which band of operation is it suited?	2
8.(a)	Solve Helmholtz scalar wave equation with reference to a circular waveguide.	12
(b)	Draw neat diagrams to show how you would excite TE_{10} TE_{20} TM_{11} and TM_{21} modes in a rectangular waveguide.	4X2