Reg. No.										

MANIPAL INSTITUTE OF TECHNOLOGY

MANIPAL

(A constituent unit of MAHE, Manipal)

SEVENTH SEMESTER BTECH. (E & C) DEGREE END SEMESTER EXAMINATION
MARCH 2021
SUBJECT: RF & MICROWAVE ENGINEERING (ECE - 4102)

TIME: 3 HOURS **MAX. MARKS: 50**

Instructions to candidates

- Answer **ALL** questions.
- Missing data may be suitably assumed.
- Use of Smith Chart is permitted and used Chart has to be uploaded

1A. Consider an arrangement as shown in **Fig. 1A** wherein a semi-infinite transmission line is realized by connecting alternating sections of lossless transmission lines of lengths s each and with characteristic impedances alternating between $R_0 = 100\ \Omega$ and $R_0/2 = 50\ \Omega$.

i. Determine the input impedance Z_s in terms of β and s

ii. What will be Z_s if βs is an integer multiple of π?

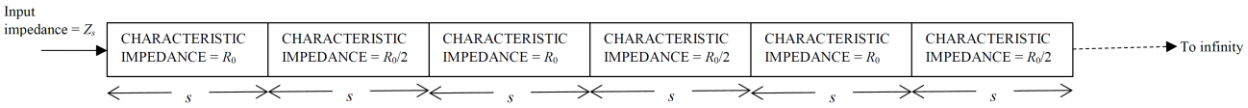

Fig. 1A

1B. A lossless transmission line of length $7\lambda/16$ has an input impedance $Z_s/R_0 = 1.2+j0.95$. Find the load impedance and the standing wave ratio.

(6+4)

2A. From the fundamentals, derive the expressions for electric and magnetic field components of fundamental TE mode propagating in a rectangular waveguide, showing all the intermediate steps.

2B. Calculate the cut-off frequency for dominant mode in a rectangular waveguide of width 10cms. Also calculate the guide wavelength, the group and phase velocities for a signal of 3GHz propagating in the waveguide in dominant mode

(6+4)

3A. Find the S parameters for a lossless 10dB directional coupler. The directivity is 30dB, and the VSWR at each port is 1.0 under matched condition

3B. With suitable examples, explain the properties of S-matrix. Prove that the S-matrix of a 3-port network cannot be matched, lossless, and reciprocal at the same time.

(5+5)

4A. Sketch a two cavity klystron with microwave signal applied $Vs=V_1\sin\omega t$. Electrons arrive cavity gap at time t_0 and leave gap at t_1. Find its velocity in terms of exit time. Also, with the help of applegate diagram, explain the bunching of electrons in drift space

4B. An X-band pulsed cylindrical magnetron is operated at cyclotron frequency 10GHz, with average velocity of electrons 0.9×10^8 m/s has the following parameter, diameter of anode cylinder is 16cm, the cut off magnetic flux density at fixed V_o is 15mWb/m^2. Calculate:

i. Fixed magnetic density
ii. The cut-off voltage for fixed B_O
iii. Radius of cathode cylinder.

Discuss about the motion of electrons with respect to above parameters

(6+4)

5A. With the help of a neat and labelled diagram, explain the various regions in the I-V characteristics of a Gunn diode. Also, explain the three criteria for a semiconductor to exhibit negative resistance and give two examples each of semiconductor materials which meet all these criteria, and which do not meet all these criteria.

5B. A helix travelling-wave tube operates at 4 GHz under a beam voltage of 10 kV and beam current of 500 mA. If the helix impedance is 60 ohms and the interaction length is 20 cm, determine:

i. circuit length in electronic wavelength
ii. gain parameter of the circuit and
iii. output power gain in dB

5C. Provide a neat and labelled diagram of a tunnel-diode reflection amplifier. If a tunnel-diode reflection amplifier has $R_n = -40$ ohms and $Z_0=50$ ohms, determine the power gain in dB.

(4+3+3)