Reg. No.										

MANIPAL INSTITUTE OF TECHNOLOGY

MANIPAL

(A constituent unit of MAHE, Manipal)

SEVENTH SEMESTER BTECH. (E & C) DEGREE END SEMESTER EXAMINATION
DECEMBER 2020/JANUARY 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.
- Smith chart will be provided.

1A. A loss less transmission line has characteristic impedance of 100 Ω. If this line is connected to a load impedance of 200-j150 Ω, determine the length *'L'* and position *'s'* of a short-circuit impedance matching stub. Take the operating frequency as 30 MHz. Solve using Smith chart.

1B. A transmission line has the following parameters. R = 3 Ω/m, G = 0.5 mS/m, L = 6 nH/m, and C = 0.2 pF/m. If the operating frequency is 1 GHz, determine the characteristic impedance and propagation constant.

1C. Starting from an infinitesimal section of a transmission line, derive and solve transmission line equations and also obtain answer in experimental form.

(4+3+3)

2A. Derive an expression for electric and magnetic fields components of fundamental mode of TE wave propagating in a rectangular waveguide by using the basic fundamentals.

2B. A rectangular wave guide has cross section of 7cm X 4cm. Determine all the possible modes of propagation at the frequency of:

(a) 3GHz (b) 5GHz (c) Determine the values of f_c, $\lambda_c, \bar{\lambda}, \bar{\alpha}, \bar{\beta}, \bar{\gamma}, and\ v_{ph}$ at 3 GHz

(5+5)

3A. Explain the construction and working of two hole directional coupler. Define its coupling coefficient, insertion loss and directivity. Also derive its S matrix.

3B. Construct four port circulator using:

i) Couplers and phase shifters

ii) Hybrid Tees and gyrator

Explain the working of the same with ideal S-matrix.

(5+5)

4A. With a neat, labelled diagram, explain the working of two cavity klystron amplifier. Find the beam coupling coefficient for a two-cavity klystron amplifier with the following specifications: Beam voltage=1500 volts, cavity gap=1mm and operating frequency=3GHz.

4B. With the help of a neat and labelled diagram, explain the two-valley model used to understand the Gunn effect. 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.

4C. With the help of a neat and labelled diagram, explain the various regions in the I-V characteristics of a tunnel diode. Also, a tunnel diode has R_n = 60 ohms, R_s = 9 ohms, C = 0.6 pF, and L_s = 1nH. Determine the self-resonant frequency.

(4+3+3)

5A. State the equations of motion for electrons in a cylindrical magnetron and derive the Hull cut-off magnetic and voltage equations (show all the intermediate steps). The operating parameters for a pulsed cylindrical magnetron are: Anode Voltage = 25 kV, Beam Current = 25 A, Magnetic flux density = 0.34 Wb/m^2 , Radius of cathode cylinder = 5 cm and Radius of anode cylinder = 10 cm. Determine:

(i) the angular frequency and

(ii) cut-off voltage for a fixed magnetic flux density

5B. With the help of neat and labelled diagram, describe the physical structure and explain the working of a helix travelling-wave tube.

5C. 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 25 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

(4+3+3)