

Code No: 137EK

R16

JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY HYDERABAD

B. Tech IV Year I Semester Examinations, March - 2021

MICROWAVE ENGINEERING
(Electronics and Communication Engineering)

Time: 3 Hours

Max. Marks: 75

Answer any Five Questions
All Questions Carry Equal Marks

- 1.a) List the microwave frequency bands.
- b) Derive field components of TE wave in rectangular wave guide. [5+10]
- 2.a) Derive the expression for group velocity (V_g) and phase velocity (V_p) for a microwave signal propagating in rectangular waveguide. Show that $V_g \times V_p = C^2$
- b) A rectangular waveguide has a cross-section area $2.29 \times 1.45 \text{ cm}^2$ and operating frequency is 10 GHz. Calculate the following
 - i) Free space wavelength
 - ii) Cut of wave length
 - iii) Cut of frequency
 - iv) Angle of incidence
 - v) Guided wavelength
 - vi) Phase velocity.[9+6]
- 3.a) Explain the functional features of Directional coupler.
- b) With the help of neat diagram explain the principle of operation of circulator.
- c) Incident power to a directional coupler is 80 watts. The direction coupler has coupling factor of 20 dB, directivity of 30 dB and insertion loss of 0.5 dB. Find the output power at (i) Main arm (ii) Coupled and (iii) Isolated ports. [5+6+4]
- 4.a) In detail explain the limitations of conventional tubes at microwave frequencies.
- b) Explain the working principle of two cavity Klystron with the help of applegate diagram. Also write the expression for velocity modulation and voltage gain. [5+10]
- 5.a) Derive the expression for bunching parameter of Reflex klystron.
- b) What is the significance of slow wave structure? Explain the amplification process in TWT. [7+8]
- 6.a) What is Hartree condition? Explain working of cylindrical travelling wave magnetron and its operation in π mode.
- b) A linear magnetron has the following operating parameters:
anode voltage $V_0 = 15 \text{ kV}$, cathode current $I_0 = 1.2 \text{ A}$, operating frequency $f = 8 \text{ GHz}$, magnetic flux density $B = 0.015 \text{ Wb/m}^2$, hub thickness $h = 2.77 \text{ cm}$, and distance between anode and cathode, $d = 5 \text{ cm}$.
Calculate
 - i) The electron velocity at the hub surface
 - ii) The phase velocity for synchronism
 - iii) The Hartree anode voltage.[10+5]

7.a) What is negative resistance phenomenon? Explain the operation and characteristics of Gunn diode

b) Determine the conductivity of n-type GaAs Gunn diode if
Electron density $n = 10^{18} \text{ cm}^{-3}$, electron density at lower valley $n_l = 10^{10} \text{ cm}^{-3}$
Electron density at upper valley $n_u = 10^8 \text{ cm}^{-3}$, temperature $T = 300^\circ \text{ K}$

[10+5]

8.a) Derive the S-matrix for H-plane Tee.

b) Draw the block diagram of microwave bench setup and explain the slotted line method of frequency measurement.

[7+8]