QK-5332-C

M. Sc. (Sem. III) Examination, December-2023

PHYSICS

PAPER - 3.4

PHY-304 (3) : Microwave Electronics-I

Time Allowed : Three Hours

Maximum Marks : 70
Min. Marks : 28

Note : This question paper contains three sections as under :

Section-A **Max. Marks - 10**

This section shall have 01 compulsory question comprising 10 questions (maximum 20 words answer) taking two questions from each unit. Each question shall be of one mark and total marks of this section will be 10. This section will be compulsory in the paper.

Section-B ***Max. Marks-25***

This section will carry 25 marks with equally divided into five long answer type questions (answer about in 250 words) and examiners are advised to set two questions from each unit and students are instructed to attempt five questions by selecting one question from each unit.

Section-C ***Max. Marks-35***

Will carry 35 marks with five long answer type questions comprising one compulsory question (question no. 07) of 15 marks and four questions of 10 marks each. Students are instructed to attempt total three questions with one compulsory question (answer about in 500 words) and any two more questions (answer about in 400 words) out of remaining four questions.

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SECTION - A

1 (i) Define TE and TM modes.

(ii) What do you understand by the terms cut off wavelength and guide wavelengths?

(iii) Explain Rosonant modes of cavity resonation.

(iv) What do you understand by Quality factor (Q) of a cavity resonator ?

(v) What is the difference between the inductance field and radiation field of an antenna.

(vi) Define and illustrate bandwidth of an antenna.

(vii) Define velocity modulation.

(viii) Describe modes of oscillation of Magnetron.

(ix) Explain Gunn effect.

(x) Write difference in TRAPATT and TMPATT.

SECTION - B

UNIT - I

2 Discuss different methods of excitation of wave guide in detail. 5

OR

Derive the expression for the attenuation of the TM_{nm} mode of a circular waveguide with finit conductivity. 5

UNIT - II

3 How is frequency measured in microwave system on a continuous basis using a frequency counter. 5

OR

Discuss propagation of microwave energy in ferrites. Hence explain the construction and working of an Isolator. 5

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UNIT - III

4 What are the three basic forms of horn antennas? Why is the horn flared?

5

OR

Derive the radiation field of Microstrip antenna. Also write microstrip design formula.

5

UNIT - IV

5 Describe the mechanism of velocity modulation in a two cavity klystron and hence obtain an expression for the bunched beam current.

5

OR

How does the reflex klystron work ? Discuss its operating characteristics and applications.

5

UNIT - V

6 Describe the Ridley-Watkins-Hilsum theory and modes of operation of Gunn diodes.

5

OR

Draw a schematic diagram of an IMPATT diode and fully explain the two effects that combine to produce a 180^{o} - phase difference between the applied voltage and the resulting current.

5

SECTION - C

7 Find expressions for the electric surface density on the walls of a rectangular waveguide for a TE_{10} mode. Why can a narrow slot be cut along the centerline of the broad wall of a rectangular waveguide without perturbing the operation of the guide.

15

8 (a) For TE_{101} mode in rectancular cavity resonator of width 'a', height 'h' and length 'd', show that the frequency of resonance is given by

$$f_r = \frac{c}{2d}\sqrt{1+\frac{d^2}{a^2}}$$

5

(b) For $a = 2$ cm, $h = 1$ cm choose 'd' so tht cavity will resonate at 10 GHz in the forgoing mode.

5

9 Discuss the concept of an image, antenna to find the field of an antenna in the vicinity of a perfect conductor. What determines the sense of the current flow in an image antenna relative to that in actual antenna?

10

10 Explain space charge spreading of electron beam. Derive an expression for maximum pervence K that can be transmitted with the beam just grazing two ends of a cylinder of length $2L$ and diameter $2a$. Calculate the value of maximum K when $2L$=2 cm and $2a$=2 cm.

10

H In a two valley model theory of Gunn diode, prove that

$$\left[\left(\frac{\mu_l - \mu_u}{\mu_l + \mu_u}\right)\left(-\frac{Edn_l}{n_l dE}\right) - P\right] > 1$$

Where μ_l and μ_u are the electron mobility in lower and upper valley respectively, E is the applied Electric field and n_l is the electron density in a power valley, P is a function of scattering mechanisms.

10
