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(SEM VII) THEORY EXAMINATION 2022-23 **MICROWAVE & RADAR ENGINEERING**

Time: 3 Hours

Note: Attempt all Sections. If you require any missing data, then choose suitably.

SECTION A

1. Attempt all questions in brief.

- Explain various losses present in waveguides. (a)
- Define characteristic impedance. (b)
- Define the term directivity and coupling factor in directional coupler. (c)
- Write down the different properties of s-matrix. (d)
- Write down the limitations of conventional tubes at microwave (e) frequencies. 242.22
- Explain why slow wave structure is used in TWTs. (f)
- Define the term VSWR. (g)
- Define the term Dielectric Constant. (h)
- Discuss the concept of low angle tracking used in RADAR. (i)
- Define the term pulse repetition frequency in radar. (j)

SECTION B

Attempt any three of the following: 2.

- Derive the field distribution of TE10 mode in rectangular waveguide. (a) Show that TE01 and TM10 modes do not exist in rectangular waveguide.
- Explain the operation of a Faraday rotation isolator with the help of (b) neat sketch. List the applications of ferrite isolator.
- (c) Compare TWT and Klystron amplifier. Explain the amplification process of Travelling Wave Tubes (TWT).
- (d) Discuss the salient features of microwave measurements. Describe a voltage standing wave ratio (VSWR) meter.
- Explain with neat diagram, the working of CW radar with non zero IF. (e)

3. Attempt any one part of the following:

- Derive the expression for field components in TE mode for circular (a) waveguide.
- (b) TE11 wave is propagating through a circular waveguide. The waveguide is air filled and has a diameter of 12cm. Calculate cut-off frequency (fc), guide wavelength for frequency of 2.5 GHz (λg) and wave impedance (Zg).

2x10 = 20

Total Marks: 100

10x3 = 30

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10x1 = 10

4. Attempt any *one* part of the following:

- (a) With a schematic describe the operation of a four port circulator. Obtain the simplified S matrix of a perfectly matched, lossless four port circulator.
- (b) Write short note on:
 - i. Phase Shifters
 - ii. Attenuators

5. Attempt any *one* part of the following:

- (a) Explain the schematic diagram, operating principle and performance characteristics of Backward Wave Oscillators (BWO).
- (b) A Two-CavityKlystron amplifier has the following parameters: $V_0 = 1000 \text{ V}, \text{ } R_0 = 40 \text{ kilo-ohm}, \text{ } I_0 = 25 \text{ mA}, \text{ } f = 3 \text{ GHz}, \text{ } d = 1 \text{ mm}, \text{ } L = 4 \text{ cm}, \text{ } \text{R}_{\text{sh}} \text{ (effective shunt impedance, excluding beam loading)} = 30 \text{ kilo-ohm}.$
 - i. Find the input gap voltage to give maximum voltage V2.
 - ii. Find the voltage gain, neglecting the beam loading in the output cavity.
 - iii. Find the efficiency of the amplifier, neglecting beam loading.

6. Attempt any *one* part of the following:

- (a) Write short note on:
 - i) Power Meters
 - ii) Microwave Amplifiers
- (b) Write short note on:
 - i) Measurement of Insertion Loss
 - ii)ReturnLoss

7. Attempt any *one* part of the following:

- (a) Derive simple form of radar range equation.
- (b) A typical pulse radar waveform has T_{on} =10μs, pulse repetition period (T_r) = 10msand peak power= 10 MW.
 Find:
 - i) Duty cycle
 - ii) Maximum unambiguous range (Run)
 - iii) Average power (P_{avg})

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