34 TRIBHUVAN UNIVERSITY
INSTITUTE OF ENGINEERING
Examination Control Division
2072 Ashwin

Exam.	**Regular**		
Level	BE	**Full Marks**	80
Programme	BEX	**Pass Marks**	32
Year / Part	IV / II	**Time**	3 hrs.

Subject: - RF and Microwave Engineering *(EX752)*

- ✓ Candidates are required to give their answers in their own words as far as practicable.
- ✓ *Attempt **All** questions.*
- ✓ *The figures in the margin indicate **Full Marks**.*
- ✓ ***Necessary Formulas and Smith Charts are attached herewith.***
- ✓ *Assume suitable data if necessary.*

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1. What are the advantages and disadvantages of microwaves over acoustic waves? [5] 4
2. What is admittance chart? A load impedance of $Z_L = 80+j100$ is connected to a microstrip transmission line. Find the size and placement of the matching stub. Use single stub shunt tuning short and open stubs. [2+8] 1+3
3. Define the use of S-parameters for three-port analysis. Define the term return loss and insertion loss. [5+2] 1
4. What are waveguide junctions? Describe the operational principles of magic tee based on s-parameters. [3+3] 2+1
5. What is density modulation? Describe the working principle of a multi-cavity klystron oscillator. [2+7] 2+5
6. Justify that a transistor having following S-parameters $S_{11} = 0.894 \angle -60.6°$, $S_{12} = 0.020 \angle 62.4°$, $S_{21} = 3.122 \angle 123.6°$ and $S_{22} = 0.781 \angle -27.6°$ is conditionally stable while designing an amplifier. Considering unilateral model calculate maximum gain. [5+5] 3+3
7. How can you implement low pass filter using micro-strip? How they are prototyped? [3+5] 2
8. Describe how standing waves and microwave powers are measured with VSWR meter and low power measurement. [2+8] 2+5
9. Write short notes on: (any three) [3×5] 2+4
   a) Dominant mode in waveguide
   b) Circulators
   c) LNA cavity device inserting loss method for filter designing
   d) Insertion loss method for filter designing

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Supplied Formula

$$K = \frac{1-|S_{11}|^2 - |S_{22}|^2 + |\Delta|^2}{2|S_{12}S_{21}|} \qquad \mu = \frac{1-|S_{11}|^2}{|S_{22} - S_{11}^*\Delta| + |S_{12}S_{21}|}$$

$$\Delta = S_{11}S_{22} - S_{12}S_{21} \qquad \Gamma_S = \frac{B_1 \pm \sqrt{B_1^2 - 4|C_1|^2}}{2C_1} \qquad \Gamma_L = \frac{B_2 \pm \sqrt{B_2^2 - 4|C_2|^2}}{2C_2}$$

$$R_L = \left| \frac{S_{12}S_{21}}{|S_{22}|^2 - |\Delta|^2} \right| \qquad B_1 = 1 + |S_{11}|^2 - |S_{22}|^2 - |\Delta|^2 \quad C_1 = S_{11} - \Delta S_{22}^*$$

$$B_2 = 1 + |S_{22}|^2 - |S_{11}|^2 - |\Delta|^2 \quad C_2 = S_{22} - \Delta S_{11}^*$$

$$C_L = \frac{(S_{22} - \Delta S_{11}^*)^*}{|S_{22}|^2 - |\Delta|^2} \qquad G_{TU} = \frac{|S_{21}|^2 (1 - |\Gamma_S|^2)(1 - |\Gamma_L|^2)}{|1 - S_{11}\Gamma_S|^2 |1 - S_{22}\Gamma_L|^2}$$

$$R_S = \left| \frac{S_{12}S_{21}}{|S_{11}|^2 - |\Delta|^2} \right| \qquad G_T = \frac{|S_{21}|^2 (1 - |\Gamma_S|^2)(1 - |\Gamma_L|^2)}{|1 - \Gamma_S\Gamma_{in}|^2 |1 - S_{22}\Gamma_L|^2}$$

$$C_S = \frac{(S_{11} - \Delta S_{22}^*)^*}{|S_{11}|^2 - |\Delta|^2}$$

Supplied Formula

Design For Maximum Gain (Conjugate Matching)

$$\Gamma_{in} = \Gamma_S^*$$

$$\Gamma_{out} = \Gamma_L^*$$

$$G_{T\max} = \frac{1}{1-|\Gamma_s|^2} |S_{21}|^2 \frac{1-|\Gamma_L|^2}{|1 - S_{22}\Gamma_L|^2}$$

$$\Gamma_S = \frac{B_1 \pm \sqrt{B_1^2 - 4|C_1|^2}}{2C_1} \qquad \Gamma_L = \frac{B_2 \pm \sqrt{B_2^2 - 4|C_2|^2}}{2C_2}$$

$$B_1 = 1 + |S_{11}|^2 - |S_{22}|^2 - |\Delta|^2 \qquad C_1 = S_{11} - \Delta S_{22}^*$$

$$B_2 = 1 + |S_{22}|^2 - |S_{11}|^2 - |\Delta|^2 \qquad C_2 = S_{22} - \Delta S_{11}^*$$

For Unilat eral $S_{12} = 0, \Gamma_S = S_{11}^*$ and $\Gamma_L = S_{22}^*$

$$G_{TU\max} = \frac{1}{1-|S_{11}|^2} |S_{21}|^2 \frac{1}{1-|S_{22}|^2}$$

$$R_S = \left| \frac{S_{12}S_{21}}{|S_{11}|^2 - |\Delta|^2} \right| \qquad K = \frac{1-|S_{11}|^2 - |S_{22}|^2 + |\Delta|^2}{2|S_{12}S_{21}|}$$

$$\mu = \frac{1-|S_{11}|^2}{|S_{22} - S_{11}^*\Delta| + |S_{12}S_{21}|} \qquad \Delta = S_{11}S_{22} - S_{12}S_{21}$$

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34 TRIBHUVAN UNIVERSITY
INSTITUTE OF ENGINEERING
Examination Control Division
2071 Bhadra

Exam.	Regular / Back		
Level	BE	Full Marks	80
Programme	BEX	Pass Marks	32
Year / Part	IV / II	Time	3 hrs.

Subject: - RF and Microwave Engineering *(EX752)*

- ✓ Candidates are required to give their answers in their own words as far as practicable.
- ✓ *Attempt **All** questions.*
- ✓ *The figures in the margin indicate **Full Marks**.*
- ✓ ***Necessary formulas and Smith Charts are attached herewith.***
- ✓ *Assume suitable data if necessary.*

1. Describe field equations and other related parameters of a rectangular waveguide in TM mode. Compare TE_{10} and TE_{20} in terms of cut-off frequency and dominant mode. [8+2]

2. Design a double stub matching network using three-eighths wavelength $\left(\frac{3\lambda}{8}\right)$ separation that match an antenna having load of 300+j300 Ohm connected to a 300 Ohm transmission line. Justify your design. [10]

3. What is bunching effect? Describe the working principle of a klystron oscillator. [2+8]

4. Using the given S-parameters $S_{11}=0.55\angle150°$, $S_{12}=0.04\angle20°$, $S_{21}=2.82\angle180°$, $S_{22}=0.45\angle-30°$ and required assumptions, calculate maximum gains of this transistor amplifier for bilateral and unilateral modes. [10]

5. Draw a flow diagram to describe the design procedure of a microwave amplifier. Define the stability of an amplifier having $C_S=1.15\angle10°$, $R_S=0.85$, $C_L=1.10\angle80°$, $R_L=1.10$. [5+5]

6. How microwave measurements are different to low frequency measurements? Describe how static calorimeter works to measure power. [3+7]

7. Design a two-port network model and derive the required parameters. [10]

8. Write short notes (Any TWO) [2x5]
   a. Design procedures of microwave filters
   b. Microwave radiation hazards and safety practices
   c. Backward Wave Oscillator
   d. Merits of S-parameters in microwaves

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Supplied Formulas:

$$K = \frac{1+|\Delta|^2 - |S_{11}|^2 - |S_{22}|^2}{2|S_{12}||S_{21}|},$$

$$\Delta = (S_{11}S_{22}) - (S_{12}S_{21}),$$

$$\mu = \frac{1-|S_{11}|^2}{|S_{22} - \Delta S_{11}^*| + |S_{21}S_{12}|}$$

$$\Gamma_S = \frac{B_1 \pm \sqrt{B_1^2 - 4|C_1|^2}}{2C_1},$$

$$\Gamma_L = \frac{B_2 \pm \sqrt{B_2^2 - 4|C_2|^2}}{2C_2}, \text{ where}$$

$$B_1 = 1+|S_{11}|^2 - |S_{22}|^2 - |\Delta|^2,$$

$$B_2 = 1+|S_{22}|^2 - |S_{11}|^2 - |\Delta|^2,$$

$$C_1 = S_{11} - \Delta S_{22}^*, \text{ and}$$

$$C_2 = S_{22} - \Delta S_{11}^*$$

$$C_L = \frac{(S_{22} - \Delta S_{11}^*)^*}{|S_{22}|^2 - |\Delta|^2}$$

$$C_S = \frac{(S_{11} - \Delta S_{22}^*)^*}{|S_{11}|^2 - |\Delta|^2}$$

$$R_L = \frac{|S_{12}S_{21}|}{|S_{22}|^2 - |\Delta|^2}$$

$$R_S = \frac{|S_{12}S_{21}|}{|S_{11}|^2 - |\Delta|^2}$$

$$G_{Tmax} = \left(\frac{1-|\Gamma_S|^2}{|1-S_{11}\Gamma_S|^2}\right)|S_{21}|^2\left(\frac{1-|\Gamma_L|^2}{|1-S_{22}\Gamma_L|^2}\right)$$

10/13 D

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INSTITUTE OF ENGINEERING
Examination Control Division
2071 Magh

Exam.	New Back (2066 & Later Batch)		
Level	BE	Full Marks	80
Programme	BEX	Pass Marks	32
Year / Part	IV / II	Time	3 hrs.

Subject: - RF and Microwave Engineering *(EX752)*

- ✓ Candidates are required to give their answers in their own words as far as practicable.
- ✓ *Attempt All questions.*
- ✓ *The figures in the margin indicate Full Marks.*
- ✓ ***Necessary figures and Smith Charts are attached herewith.***
- ✓ *Assume suitable data if necessary.*

1. Differentiate the behaviors of the systems at microwave and conventional low frequency bands. [6]

2. Describe how TE mode is different from TM mode in a circular waveguide. [10]

3. Describe the working principle of a cavity magnetron. [10]

4. Why S-parameter is important in microwave network analysis? Define S-parameters for a two-port network. [4+5]

5. By arbitrarily assuming a suitable load that connects to a 50-ohm transmission line find the lengths and spacing for a two-stub impedance matching system. Assume also a suitable separation between the stubs. [10]

6. Using the following S-parameters of $S_{11}=0.55\angle-150°$, $S_{12}=0.04\angle20°$, $S_{21}=2.82\angle180°$ and $S_{22}=0.45\angle-30°$, calculate and compare maximum power gain for unilateral and bilateral modes. [15]

7. Discuss the difference between an amplifier circuit and an oscillator circuit in terms of stability factor. [5]

8. Write short notes (Any THREE) [3 x 5]
   a. Microwave magic tee
   b. Microwave radiation fields
   c. Microwave strip-lines against micro-strips
   d. Static calorimeter

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Supplied Formulas:

$K=\dfrac{1+|\Delta|^2-|S_{11}|^2-|S_{22}|^2}{2|S_{12}||S_{21}|}$,

$\Delta=(S_{11}S_{22})-(S_{12}S_{21})$,

$\mu=\dfrac{1-|S_{11}|^2}{|S_{22}-\Delta S_{11}^*|+|S_{21}S_{12}|}$

$\Gamma_S=\dfrac{B_1\pm\sqrt{B_1^2-4|C_1|^2}}{2C_1}$,

$\Gamma_L=\dfrac{B_2\pm\sqrt{B_2^2-4|C_2|^2}}{2C_2}$, where :

$B_1=1+|S_{11}|^2-|S_{22}|^2-|\Delta|^2$,

$B_2=1+|S_{22}|^2-|S_{11}|^2-|\Delta|^2$,

$C_1=S_{11}-\Delta S_{22}^*$, and

$C_2=S_{22}-\Delta S_{11}^*$

$C_L=\dfrac{(S_{22}-\Delta S_{11}^*)^*}{|S_{22}|^2-|\Delta|^2}$

$C_S=\dfrac{(S_{11}-\Delta S_{22}^*)^*}{|S_{11}|^2-|\Delta|^2}$

$R_L=\dfrac{|S_{12}S_{21}|}{|S_{22}|^2-|\Delta|^2}$

$R_S=\dfrac{|S_{12}S_{21}|}{|S_{11}|^2-|\Delta|^2}$

$G_{Tmax}=\left(\dfrac{1-|\Gamma_S|^2}{|1-S_{11}\Gamma_S|^2}\right)|S_{21}|^2\left(\dfrac{1-|\Gamma_L|^2}{|1-S_{22}\Gamma_L|^2}\right)$

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INSTITUTE OF ENGINEERING

Examination Control Division

2070 Bhadra

Exam.	**Regular**		
Level	BE	**Full Marks**	80
Programme	BEX	**Pass Marks**	32
Year / Part	IV / II	**Time**	3 hrs.

Subject: - RF and Microwave Engineering ***(EX752)***

- ✓ Candidates are required to give their answers in their own words as far as practicable.
- ✓ *Attempt **All** questions.*
- ✓ *The figures in the margin indicate **Full Marks**.*
- ✓ ***Necessary formulas and Smith charts are attached herewith.***
- ✓ *Assume suitable data if necessary.*

1. Based on operational principles, compare microwave systems with conventional low frequency systems. Lists the areas of application of microwave systems. [4+4]
2. What makes S-parameters useful in microwave network analysis? Define S-parameters for a two-port network. Justify that the Butterworth and Chebyshev filter responses are common to prototype microwave two-port filter network using insertion loss method. [4+4+4]
3. Design a double-stub impedance matching network for a given load of 80 + j180 Ohm connected to a 100-Ohm transmission line at 3 GHz with a three-eights wavelength separation between the stubs. Illustrate necessary diagrams to show physical connections. [8+2]
4. Define expressions for various field components of a rectangular waveguide in TE mode. Show that a 1 GHz signal cannot propagate in TE_{10} made in a rectangular waveguide with a wall separation of 5 cm. [7+3]
5. Find the maximum gain for a microwave transistor amplifier with $S_{11} = 0.656\angle 146.7°$, $S_{12} = 0.122\angle 46.1°$, $S_{21} = 2.3\angle 44.7°$, $S_{22} = 0.172\angle -117.1°$. [10]
6. What is bunching effect? Briefly describe the construction and operational features of a cavity magnetron. [2+8]
7. Describe how standing waves and microwave powers are measured with VSWR meter and bolometry respectively. [4+6]
8. Write short notes on: (any two) [2×5]
   a) Mixer theory
   b) Circulators
   c) Microwave radiation hazards and safety practices

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Supplied Formulas:

$$K = \frac{1+|\Delta|^2 - |S_{11}|^2 - |S_{22}|^2}{2|S_{12}||S_{21}|},$$

$$\Delta = (S_{11}S_{22}) - (S_{12}S_{21}),$$

$$\mu = \frac{1-|S_{11}|^2}{|S_{22} - \Delta S_{11}^*| + |S_{21}S_{12}|}$$

$$\Gamma_S = \frac{B_1 \pm \sqrt{B_1^2 - 4|C_1|^2}}{2C_1},$$

$$\Gamma_L = \frac{B_2 \pm \sqrt{B_2^2 - 4|C_2|^2}}{2C_2}, \text{ where}$$

$$B_1 = 1+|S_{11}|^2 - |S_{22}|^2 - |\Delta|^2,$$

$$B_2 = 1+|S_{22}|^2 - |S_{11}|^2 - |\Delta|^2,$$

$$C_1 = S_{11} - \Delta S_{22}^*, \text{ and}$$

$$C_2 = S_{22} - \Delta S_{11}^*$$

$$C_L = \frac{(S_{22} - \Delta S_{11}^*)^*}{|S_{22}|^2 - |\Delta|^2}$$

$$C_S = \frac{(S_{11} - \Delta S_{22}^*)^*}{|S_{11}|^2 - |\Delta|^2}$$

$$R_L = \frac{|S_{12}S_{21}|}{|S_{22}|^2 - |\Delta|^2}$$

$$R_S = \frac{|S_{12}S_{21}|}{|S_{11}|^2 - |\Delta|^2}$$

$$G_{T\max} = \left(\frac{1}{1-|\Gamma_S|^2}\right)|S_{21}|^2\left(\frac{1-|\Gamma_L|^2}{|1-S_{22}\Gamma_L|^2}\right)$$

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INSTITUTE OF ENGINEERING

Examination Control Division

2070 Magh

Exam.	**New Back (2066 & Later Batch)**		
Level	BE	**Full Marks**	80
Programme	BEX	**Pass Marks**	32
Year / Part	IV / II	**Time**	3 hrs.

Subject: - RF and Microwave Engineering *(EX752)*

- ✓ Candidates are required to give their answers in their own words as far as practicable.
- ✓ *Attempt **All** questions.*
- ✓ *The figures in the margin indicate **Full Marks**.*
- ✓ ***Necessary formulas and Smith charts are supplied herewith.***
- ✓ *Assume suitable data if necessary.*

1. Differentiate between conventional low frequency and microwave systems based on their working principles. Lists the area of application of microwave systems. [4+4]

2. Justify that S-parameters are used in microwaves instead of h-parameters for network analysis. Define S-parameter for a two-port network. Why the Butterworth and Chebyshev filter responses are common to prototype microwave two-port filter network insertion loss method? [4+4+4]

3. Design a double-stub impedance matching network for a given load of 190+j 110 Ohms connected to be 100-Ohm transmission line at 10 GHz with a three-eight wavelength separation between the stubs. Illustrate necessary diagrams to show physical connections. [8+2]

4. Define expressions for various field components of a rectangular waveguide in TM mode. Prove that TM_{01} and TM_{10} modes do not exist in a rectangular waveguide. [7+3]

5. Justify that a transistor having following S-parameters $S_{11} = 0.894\angle{-60.6°}$, $S_{12} = 0.020\angle{62.4°}$, $S_{21} = 3.122\angle{123.6°}$ and $S_{22} = 0.781\angle{-27.6°}$ is conditionally stable while designing an amplifier. [10]

6. What is transit time effect? Briefly describe the construction and principle of operation of a two-cavity klystron amplifier. [2+8]

7. What is calorimetry in microwave? Differentiate between circulating and flow calorimetries based on principles of operation. [2+8]

8. Write short notes: (any two) [2+8]

   a) Hybrid tee
   b) Microwave oscillator theory
   c) RF radiation hazards and safety standards

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Supplied Formulas:

$$K=\frac{1+|\Delta|^2-|S_{11}|^2-|S_{22}|^2}{2|S_{12}||S_{21}|},$$

$$\Delta=(S_{11}S_{22})-(S_{12}S_{21}),$$

$$\mu=\frac{1-|S_{11}|^2}{|S_{22}-\Delta S_{11}^*|+|S_{21}S_{12}|}$$

$$\Gamma_S=\frac{B_1\pm\sqrt{B_1^2-4|C_1|^2}}{2C_1},$$

$$\Gamma_L=\frac{B_2\pm\sqrt{B_2^2-4|C_2|^2}}{2C_2}, \text{ where}$$

$$B_1=1+|S_{11}|^2-|S_{22}|^2-|\Delta|^2,$$

$$B_2=1+|S_{22}|^2-|S_{11}|^2-|\Delta|^2,$$

$$C_1=S_{11}-\Delta S_{22}^*, \text{ and}$$

$$C_2=S_{22}-\Delta S_{11}^*$$

$$C_L=\frac{(S_{22}-\Delta S_{11}^*)^*}{|S_{22}|^2-|\Delta|^2}$$

$$C_S=\frac{(S_{11}-\Delta S_{22}^*)^*}{|S_{11}|^2-|\Delta|^2}$$

$$R_L=\frac{|S_{12}S_{21}|}{|S_{22}|^2-|\Delta|^2}$$

$$R_S=\frac{|S_{12}S_{21}|}{|S_{11}|^2-|\Delta|^2}$$

$$G_{T\max}=\left(\frac{1}{1-|\Gamma_S|^2}\right)|S_{21}|^2\left(\frac{1-|\Gamma_L|^2}{|1-S_{22}\Gamma_L|^2}\right)$$

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INSTITUTE OF ENGINEERING

Examination Control Division

2069 Bhadra

Exam.	**Regular / Back**		
Level	BE	**Full Marks**	80
Programme	BEX	**Pass Marks**	32
Year / Part	IV / II	**Time**	3 hrs.

Subject: - RF & Microwave Circuits, Systems & Devices *(EG785EX) (Elective II)*

- ✓ Candidates are required to give their answers in their own words as far as practicable.
- ✓ *Attempt **All** questions.*
- ✓ *The figures in the margin indicate **Full Marks**.*
- ✓ ***Necessary formulas and smith chart are attached herewith.***
- ✓ *Assume suitable data if necessary.*

1. Classify microwave frequency bands and state their major applications. Describe how microwave transmission lines are different from the conventional low frequency transmission lines. [4+4]

2. Describe microwave radiation hazards based on the radiation fields. [8]

3. Describe rectangular waveguide based on modes on propagation and other critical parameters. [8]

4. Describe why S-parameter is important in microwave network analysis. Using a two-port network derive S-parameters. [4+6]

5. What is double-stub tuner? Assuming a load of 75 + *j*75 ohm is connected to a 50-ohm transmission line, find the lengths and spacing for a two-stub impedance matching system with three-eights wavelength separation between the stubs. [3+15]

6. Design an amplifier to attain maximum gain at 4.0 GHz using a GaAs FET having following S-parameters: $S_{11} = 0.72\angle -116°$, $S_{12} = 0.03\angle 57°$, $S_{21} = 2.60\angle 76°$ and $S_{22} = 0.73\angle -54°$. Consider the characteristic impedance, $Z_o = 50$ Ohm. [18]

7. Write short notes (Any TWO) [2 x 5]
    a. E-plane tee against H-plane tee
    b. PROBE-coupling against LOOP-coupling
    c. Microstrips
    d. Two-cavity klystron

***

Supplied Formulas:

$$K = \frac{1 + |\Delta|^2 - |S_{11}|^2 - |S_{22}|^2}{2|S_{12}||S_{21}|},$$

$$\Delta = (S_{11}S_{22}) - (S_{12}S_{21}),$$

$$\mu = \frac{1 - |S_{11}|^2}{|S_{22} - \Delta S_{11}^*| + |S_{21}S_{12}|}$$

$$\Gamma_S = \frac{B_1 \pm \sqrt{B_1^2 - 4|C_1|^2}}{2C_1},$$

$$\Gamma_L = \frac{B_2 \pm \sqrt{B_2^2 - 4|C_2|^2}}{2C_2}, \text{ where}$$

$$B_1 = 1 + |S_{11}|^2 - |S_{22}|^2 - |\Delta|^2,$$

$$B_2 = 1 + |S_{22}|^2 - |S_{11}|^2 - |\Delta|^2,$$

$$C_1 = S_{11} - \Delta S_{22}^*, \text{ and}$$

$$C_2 = S_{22} - \Delta S_{11}^*$$

$$C_L = \frac{(S_{22} - \Delta S_{11}^*)^*}{|S_{22}|^2 - |\Delta|^2}$$

$$C_S = \frac{(S_{11} - \Delta S_{22}^*)^*}{|S_{11}|^2 - |\Delta|^2}$$

$$R_L = \frac{|S_{12}S_{21}|}{|S_{22}|^2 - |\Delta|^2}$$

$$R_S = \frac{|S_{12}S_{21}|}{|S_{11}|^2 - |\Delta|^2}$$

$$G_{T\max} = \left(\frac{1}{1 - |\Gamma_S|^2}\right)|S_{21}|^2\left(\frac{1 - |\Gamma_L|^2}{|1 - S_{22}\Gamma_L|^2}\right)$$

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INSTITUTE OF ENGINEERING

Examination Control Division

2075 Bhadra

Exam.	Regular		
Level	BE	Full Marks	80
Programme	BEX	Pass Marks	32
Year / Part	IV / II	Time	3 hrs.

Subject: - RF and Microwave Engineering *(EX752)*

- ✓ Candidates are required to give their answers in their own words as far as practicable.
- ✓ *Attempt __All__ questions.*
- ✓ *The figures in the margin indicate __Full Marks__.*
- ✓ ***__Necessary formulas and smith charts are provided herewith.__***
- ✓ *Assume suitable data if necessary.*

1. How the circuit at seismic band is different from its RF/Microwave counterparts? Explain. [8]

2. A 75-ohm, coaxial line is terminated with a normalized complex load of 0.4 + j0.85 ohms. Design a double-stub matching system using short-circuited coaxial line of 75-ohm characteristic impedance. Sketch the network using micro strip. [10+2]

3. a) Analyze a three-port directional coupler using S-parameters. [4]

   b) Which of the passive microwave device is explained by this S-matrix. Judge the condition and explain its characteristics.

$$[S]=\begin{bmatrix} S_{11} & 0 & S_{13} & S_{14} \\ 0 & S_{22} & -S_{13} & S_{14} \\ S_{13} & -S_{13} & 0 & 0 \\ S_{14} & S_{14} & 0 & 0 \end{bmatrix}$$ [6]

4. Derive the expression for the field strength for TM waves for a air-filled circular waveguide. Check the dominant mode in TE and TM modes. [8+2]

5. With neat circuit diagrams and relevant equations, explain the velocity modulation process and bunching in a multicavity reflex klystron. [10]

6. a) Refer the sketched smith chart (Fig.Q6) and analyze/synthesize the stabilities. Assume necessary parameters as desired. Mention all the steps. [5]

   b) Describe the insertion loss method used for the filter designing. [5]

7. a) Discuss in detail the power measurement using circulating calorimeter. [5]

   b) How microwave radiation becomes hazardous to human body? [5]

8. What do you understand by immitance chart? Sketch it. List out all duality parameters vital to designing microwave networks. [10]

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$$|\Delta| = |S_{11}S_{22} - S_{12}S_{21}|$$

$$K = \frac{1 - |S_{11}|^2 - |S_{22}|^2 + |\Delta|^2}{2|S_{12}S_{21}|}$$

$$\mu = \frac{1 - |S_{11}|^2}{|S_{22} - \Delta S_{11}^*| + |S_{12}S_{21}|}$$

$$C_L = \frac{(S_{22} - \Delta S_{11}^*)^*}{|S_{22}|^2 - |\Delta|^2}$$

$$R_L = \frac{|S_{12}S_{21}|}{|S_{22}|^2 - |\Delta|^2}$$

$$\Gamma_S = \frac{B_1 \pm \sqrt{B_1^2 - 4|C_1|^2}}{2C_1}.$$

$$B_1 = 1 + |S_{11}|^2 - |S_{22}|^2 - |\Delta|^2,$$

$$G_{TU_{max}} = \frac{1}{1 - |S_{11}|^2}|S_{21}|^2\frac{1}{1 - |S_{22}|^2}.$$

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INSTITUTE OF ENGINEERING

Examination Control Division

2074 Bhadra

Exam.	Regular		
Level	BE	Full Marks	80
Programme	BEX	Pass Marks	32
Year / Part	IV / II	Time	3 hrs.

Subject: - RF and Microwave Engineering *(EX752)*

- ✓ Candidates are required to give their answers in their own words as far as practicable.
- ✓ *Attempt __All__ questions.*
- ✓ *The figures in the margin indicate __Full Marks__.*
- ✓ *__Necessary figures and Chart are attached herewith.__*
- ✓ *Assume suitable data if necessary.*

1. Design a single short and open-circuited shunt matching network for a transmission line using Smith Chart by considering an output reflection coefficient $\Gamma_L = 0.5\angle 51°$ Ohm and surge impedance $Z_0 = 50$ Ohm. [8]

2. Indentify and explain the properties of a microwave passive device having following S-Matrix. [8]

$$\begin{bmatrix} S_{11} & S_{12} & S_{13} & S_{14} \\ S_{21} & S_{22} & {}_{13} & -S_{14} \\ S_{13} & S_{13} & 0 & 0 \\ S_{14} & -S_{14} & 0 & 0 \end{bmatrix}$$

3. Sketch a flowchart for designing a microwave amplifier using a GaAsFET. Consider the following S-parameters and find maximum gain for both bilateral and unilateral model. Also using the calculated value of Γ_{in} and Γ_{out} trace Z_{in} and Z_{out} in the smith chart. [4+4+4+4]

$$[S] = \begin{bmatrix} 0.656\angle 146.7° & 0.122\angle 46.1° \\ 2.30\angle 44.7° & 0.172\angle -117.1° \end{bmatrix}$$

4. Synthesize stability parameters of input matching network for the attached sketched smith chart. [8]

5. Choose a proper microwave measurement tool to test an antenna as a DUT; and explain its working principles. [8]

6. Explain in detail the designing steps of microwave filters. Illustrate an example of passive HPF using microstrips. [6+4]

7. Express field equations of a rectangular waveguide for TM mode. [10]

8. Write short notes on: (any two) [6×2]
   i) Effect of SAR as microwave radiation hazards
   ii) Features of microwave frequency band
   iii) Backward Wave Oscillator
   iv) Microwave Cavity Resonators

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$$K = \frac{1+|\Delta|^2 - |S_{11}|^2 - |S_{22}|^2}{2|S_{12}||S_{21}|},$$

$$\Delta = (S_{11}S_{22}) - (S_{12}S_{21}),$$

$$\mu = \frac{1-|S_{11}|^2}{|S_{22} - \Delta S_{11}^*| + |S_{21}S_{12}|}$$

$$\Gamma_S = \frac{B_1 \pm \sqrt{B_1^2 - 4|C_1|^2}}{2C_1},$$

$$\Gamma_L = \frac{B_2 \pm \sqrt{B_2^2 - 4|C_2|^2}}{2C_2},$$ where

$$B_1 = 1+|S_{11}|^2 - |S_{22}|^2 - |\Delta|^2,$$

$$B_2 = 1+|S_{22}|^2 - |S_{11}|^2 - |\Delta|^2,$$

$$C_1 = S_{11} - \Delta S_{22}^*,$$ and

$$C_2 = S_{22} - \Delta S_{11}^*$$

$$C_L = \frac{(S_{22} - \Delta S_{11}^*)^*}{|S_{22}|^2 - |\Delta|^2}$$

$$C_S = \frac{(S_{11} - \Delta S_{22}^*)^*}{|S_{11}|^2 - |\Delta|^2}$$

$$R_l = \frac{|S_{12}S_{21}|}{|S_{22}|^2 - |\Delta|^2}$$

$$R_S = \frac{|S_{12}S_{21}|}{|S_{11}|^2 - |\Delta|^2}$$

$$G_{Tmax} = \left(\frac{1}{|1-S_{11}\Gamma_S|^2}\right) |S_{21}|^2 \left(\frac{1-|\Gamma_L|^2}{|1-S_{22}\Gamma_L|^2}\right)$$

34 TRIBHUVAN UNIVERSITY

INSTITUTE OF ENGINEERING

Examination Control Division

2073 Magh

Exam.	New Back (2066 & Later Batch)		
Level	BE	Full Marks	80
Programme	BEX	Pass Marks	32
Year / Part	IV / II	Time	3 hrs.

Subject: - RF and Microwave Engineering *(EX 752)*

- ✓ Candidates are required to give their answers in their own words as far as practicable.
- ✓ *Attempt **All** questions.*
- ✓ *The figures in the margin indicate **Full Marks**.*
- ✓ ***Necessary Formulas and Smith Charts are attached herewith.***
- ✓ *Assume suitable data if necessary.*

1. Differentiate between lumped and distributed circuit analysis. What are the uses of microwave bands? [4+2]
2. Assume an inductive load impedance is connected to a mismatched 50Ω transmission line. Find the size and placement of the matching stub that will remove all the standing waves and match load to the line. Use double stub shunt tuning short and open circuited stub. Draw its electrical diagram and physical connection. [8]
3. Why we use S-parameters for microwave analysis? Define S-matrix for 3 port network with appropriate example. [4+4]
4. Choose a suitable passive microwave device to split power into half and explain its properties. [8]
5. Explain what is bunching effect. Explain the working principle of BWO with neat diagrams. [2+8]
6. Check the stability and find the maximum gain a transistor amplifier having $S_{11} = 0.64\angle-169°$, $S_{12} = 0.03\angle50°$, $S_{21} = 10.11\angle91°$, $S_{22} = 0.22\angle-82°$. Consider both bilateral and unilateral model. Modify the S-parameters if necessary. [12]
7. Describe insertion loss method of microwave filter design. Illustrate an example of a passive LPF using μ-strip. [8+2]
8. Describe the working principle of a network analyzer. [8]
9. Write short notes on: (Any two) [2×5]
   a) Microwave Circulators
   b) TM mode for rectangular waveguides
   c) Microwave radiation hazards

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Supplied Formulas:

$$K = \frac{1 + |\Delta|^2 - |S_{11}|^2 - |S_{22}|^2}{2|S_{12}||S_{21}|}$$

$$\Delta = (S_{11}S_{22} - S_{12}S_{21})$$

$$\mu = \frac{1 - |S_{11}|^2}{|S_{22} - \Delta S^*_{11}| + |S_{21}S_{12}|}$$

$$\Gamma_S = \frac{B_1 \pm \sqrt{B_1^{\,2} - 4|C_1|^2}}{2C_1}$$

~~$\Gamma_L = \dfrac{B_2 \pm \sqrt{B_2^{\,2} - 4|C_2|^2}}{2C_2}$~~

Where, $B_1 = 1 + |S_{11}|^2 - |S_{22}|^2 - |\Delta|^2$,

~~$B_2 = 1 + |S_{22}|^2 - |S_{11}|^2 - |\Delta|^2$~~

$$C_1 = S_{11} - \Delta S^*_{22}$$

~~$C_2 = S_{22} - \Delta S^*_{11}$~~

$$C_L = \frac{(S_{22} - \Delta S^*_{11})}{|S_{22}|^2 - |\Delta|^2}$$

$$C_S = \frac{(S_{11} - \Delta S^*_{22})}{|S_{11}|^2 - |\Delta|^2}$$

$$R_L = \frac{|S_{12}S_{21}|}{|S_{22}|^2 - |\Delta|^2}$$

~~$R_S = \dfrac{|S_{12}S_{21}|}{|S_{11}|^2 - |\Delta|^2}$~~

$$G_{Tmax} = \left(\frac{1}{1 - |\Gamma_S|^2}\right)|S_{21}|^2\left(\frac{1 - |\Gamma_L|^2}{|1 - S_{22}\Gamma_L|^2}\right)$$

~~For unilateral mode $S_{12} = 0$, $\Gamma_S = S^*_{11}$ and $\Gamma_L = S^*_{22}$~~

34 TRIBHUVAN UNIVERSITY

INSTITUTE OF ENGINEERING

Examination Control Division

2073 Bhadra

Exam.	Regular		
Level	BE	Full Marks	80
Programme	BEX	Pass Marks	32
Year / Part	IV / II	Time	3 hrs.

Subject: - RF and Microwave Engineering *(EX752)*

- ✓ Candidates are required to give their answers in their own words as far as practicable.
- ✓ *Attempt **All** questions.*
- ✓ *The figures in the margin indicate **Full Marks**.*
- ✓ ***Necessary formula, graph and figures are attached herewith.***
- ✓ *Assume suitable data if necessary.*

1. Classify signal frequency in different bands of waves and rays. What are the advantages and disadvantages of using microwave signal? [3+5]
2. By assuming a complex inductive load of an antenna which is mismatched with the line impedance of 78.0 ohm, design a double-stub short-circuited matching network. Show both electrical and physical connections. [8+2]
3. Why S-parameter is important in microwave network analysis? Write down the properties of a 3-port network. [4+4]
4. Suppose there are two identical radar transmitters and few passive devices in equipment stock. A particular application requires twice more input power to an antenna than either transmitter can deliver. As a RF engineer, give your appropriate solution for the above problem with necessary figures, mathematics and sufficient explanation. [8]
5. What do you mean by slow backward wave structure? Explain the construction and working principle of a LNA. [2+6]
6. Show a flow diagram that explain designing of an amplifier using a FET transistor. With self-defined parameters and the help of a smith chart define conditional stability of a microwave amplifier. [10]
7. Justify and describe how a microwave filter is designed using insertion loss method. [2+6]
8. Define major microwave measurement parameters and explain the working principle of a low microwave power measurement device. [8]
9. Write short notes on: (any two) [2×6]
   a) RF/MW radiation hazards and safety practices
   b) Directional Couplers
   c) TE mode circular wave guide

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Supplied Formulas:

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$$\Gamma_S = \frac{B_1 \pm \sqrt{B_1^{\,2} - 4|C_1|^2}}{2C_1}$$

$$\Gamma_L = \frac{B_2 \pm \sqrt{B_2^{\,2} - 4|C_2|^2}}{2C_2}$$

Where, $B_1 = 1 + |S_{11}|^2 - |S_{22}|^2 - |\Delta|^2$

$B_2 = 1 + |S_{22}|^2 - |S_{11}|^2 - |\Delta|^2$

$C_1 = S_{11} - \Delta S^*_{22}$

$C_2 = S_{22} - \Delta S^*_{11}$

$$C_L = \frac{(S_{22} - \Delta S^*_{11})}{|S_{22}|^2 - |\Delta|^2}$$

$$C_S = \frac{(S_{11} - \Delta S^*_{22})}{|S_{11}|^2 - |\Delta|^2}$$

$$R_L = \frac{|S_{12}S_{21}|}{|S_{22}|^2 - |\Delta|^2}$$

$$R_S = \frac{|S_{12}S_{21}|}{|S_{11}|^2 - |\Delta|^2}$$

$$G_{T\,max} = \left(\frac{1}{1 - |\Gamma_S|^2}\right)|S_{21}|^2\left(\frac{1 - |\Gamma_L|^2}{|1 - S_{22}\Gamma_L|^2}\right)$$

For unilateral mode $S_{12} = 0$, $\Gamma_S = S^*_{11}$ and $\Gamma_L = S^*_{22}$