# SUBJECT No.1

**Time allowed: 2 hours; All materials/equipments authorized**

Instructor, sl. Radu Damian Student: _________________________________ Grupa_______

**Note**. Except where otherwise specified, assume 50Ω reference impedance.
**Note**. Any CAD solution (Matlab, Mathcad, ADS) must be accompanied by the submission of the script/project at the end of the examination.

1. Compute the normalized admittance if the impedance is 35.1Ω + j·59.1Ω and the reference impedance is 75Ω. **(1p)**
2. Outline a Smith Chart (only the external circle and the complex plane axes) and plot the point corresponding to an admittance equal to 0.0344S + j·0.0215S. **(1p)**
3. A lossless coupler designed to work on 50Ω terminations has a coupling factor equal to 4.25dB and a isolation equal to 23.5dB. If the input power (50Ω source) is 3.25mW:
   a) Compute the isolated output power (**in dBm and μW**). **(1p)**
   b) Design an ideal coupled line coupler for the specified coupling factor. **(1p)**
4. A quarter wave transformer is designed to match a 57Ω load to a 50Ω feed line at 7.0GHz.
   a) Design the quarter wave transformer. **(0.5p)**
   b) If at the load in series with the 57Ω resistance we add a 0.37pF capacitor compute the resulting input impedance. **(1.5p)**
5. In order to obtain an 15.30dB gain (minimum) amplifier you must connect in series two devices. You have available the four devices in the following table.

| Device | 1 | 2 | 3 | 4 |
|---|---|---|---|---|
| Gain [dB] | 6.7 | 7.8 | 8.3 | 10.9 |
| Noise Factor [dB] | 0.55 | 0.87 | 1.06 | 1.28 |

   a) Specify any two devices you can use to meet the amplifier requirements. **(0.5p)**
   b) Of all the combinations that meet the requirements, which one has the minimum noise factor? Explain your choice. **(1.5p)**
6. The scattering parameters of a transistor at 8.6 GHz are as follows:

| $S_{11}$ | | $S_{12}$ | | $S_{21}$ | | $S_{22}$ | |
|---|---|---|---|---|---|---|---|
| Mag. | Ang. | Mag. | Ang. | Mag. | Ang. | Mag. | Ang. |
| 0.662 | -158.8° | 0.070 | 5.4° | 2.576 | 33.6° | 0.516 | -101.4° |

   a) Prove that the transistor **can be** conjugately matched (50Ω) for maximum gain. (**0.5p**)
   b) Which is the transducer power gain we obtain in this case (in dB)? (**0.5p**)
   b) Compute the input and output reflection coefficients (towards the source and load) needed for conjugate match. **(1p)**
   c) Design the match with single-stub matching sections (any solution). **(1p)**
   d) If for better gain you must add another transistor of the same type, design the matching section between the two amplifier stages (any solution). **(1p)**
   e) In the d) case, which of all solutions for the interstage matching section requires the least substrate area (assume T shape layout)? Explain your choice. **(2p)**

**U N I V E R S I T A T E A   T E H N I C Ă   " G H E O R G H E   A S A C H I "   D I N   I A Ş I**
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Domain: Telecommunication Technologies and Systems
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# *S U B J E C T   N o . 2*

**Time allowed: 2 hours; All materials/equipments authorized**

Instructor, sl. Radu Damian    Student: ________________________________   Grupa_______

**Note**. Except where otherwise specified, assume 50Ω reference impedance.
**Note**. Any CAD solution (Matlab, Mathcad, ADS) must be accompanied by the submission of the script/project at the end of the examination.

1. Compute the normalized admittance if the impedance is 54.8Ω + j·60.4Ω and the reference impedance is 40Ω. **(1p)**
2. Outline a Smith Chart (only the external circle and the complex plane axes) and plot the point corresponding to an admittance equal to 0.0360S − j·0.0255S. **(1p)**
3. A lossless coupler designed to work on 50Ω terminations has a coupling factor equal to 5.50dB and a isolation equal to 22.8dB. If the input power (50Ω source) is 2.70mW:
   a) Compute the isolated output power (<u>**in dBm and μW**</u>). **(1p)**
   b) Design an ideal ring coupler for the specified coupling factor. **(1p)**
4. A quarter wave transformer is designed to match a 40Ω load to a 50Ω feed line at 7.4GHz.
   a) Design the quarter wave transformer. **(0.5p)**
   b) If at the load in parallel with the 40Ω resistance we add a 0.31pF capacitor compute the resulting input impedance. **(1.5p)**
5. In order to obtain an 16.20dB gain (minimum) amplifier you must connect in series two devices. You have available the four devices in the following table.

| **Device** | **1** | **2** | **3** | **4** |
|---|---|---|---|---|
| Gain [dB] | 6.3 | 7.0 | 9.5 | 11.8 |
| Noise Factor [dB] | 0.54 | 0.88 | 0.99 | 1.12 |

   a) Specify any two devices you can use to meet the amplifier requirements. **(0.5p)**
   b) Of all the combinations that meet the requirements, which one has the minimum noise factor? Explain your choice. **(1.5p)**

6. The scattering parameters of a transistor at 12.5 GHz are as follows:

| $S_{11}$ | | $S_{12}$ | | $S_{21}$ | | $S_{22}$ | |
|---|---|---|---|---|---|---|---|
| Mag. | Ang. | Mag. | Ang. | Mag. | Ang. | Mag. | Ang. |
| 0.640 | 151.5° | 0.090 | -29.5° | 1.737 | -16.5° | 0.550 | -145.0° |

   a) Prove that the transistor <u>**can be**</u> conjugately matched (50Ω) for maximum gain. (**0.5p**)
   b) Which is the transducer power gain we obtain in this case (in dB)? (**0.5p**)
   b) Compute the input and output reflection coefficients (towards the source and load) needed for conjugate match. **(1p)**
   c) Design the match with single-stub matching sections (any solution). **(1p)**
   d) If for better gain you must add another transistor of the same type, design the matching section between the two amplifier stages (any solution). **(1p)**
   e) In the d) case, which of all solutions for the interstage matching section requires the least substrate area (assume T shape layout)? Explain your choice. **(2p)**

# SUBJECT No.3

**Time allowed: 2 hours; All materials/equipments authorized**

Instructor, sl. Radu Damian Student: _________________________________ Grupa_______

**Note**. Except where otherwise specified, assume 50Ω reference impedance.
**Note**. Any CAD solution (Matlab, Mathcad, ADS) must be accompanied by the submission of the script/project at the end of the examination.

1. Compute the normalized admittance if the impedance is 39.8Ω − j·57.3Ω and the reference impedance is 80Ω. **(1p)**
2. Outline a Smith Chart (only the external circle and the complex plane axes) and plot the point corresponding to an admittance equal to 0.0196S − j·0.0397S. **(1p)**
3. A lossless coupler designed to work on 50Ω terminations has a coupling factor equal to 4.75dB and a isolation equal to 24.0dB. If the input power (50Ω source) is 2.30mW:
   a) Compute the isolated output power (**in dBm and μW**). **(1p)**
   b) Design an ideal ring coupler for the specified coupling factor. **(1p)**
4. A quarter wave transformer is designed to match a 57Ω load to a 50Ω feed line at 8.3GHz.
   a) Design the quarter wave transformer. **(0.5p)**
   b) If at the load in series with the 57Ω resistance we add a 0.34pF capacitor compute the resulting input impedance. **(1.5p)**
5. In order to obtain an 14.05dB gain (minimum) amplifier you must connect in series two devices. You have available the four devices in the following table.

| **Device** | **1** | **2** | **3** | **4** |
|---|---|---|---|---|
| Gain [dB] | 5.1 | 8.8 | 8.5 | 11.8 |
| Noise Factor [dB] | 0.50 | 0.84 | 0.99 | 1.15 |

   a) Specify any two devices you can use to meet the amplifier requirements. **(0.5p)**
   b) Of all the combinations that meet the requirements, which one has the minimum noise factor? Explain your choice. **(1.5p)**
6. The scattering parameters of a transistor at 14.7 GHz are as follows:

| $S_{11}$ | | $S_{12}$ | | $S_{21}$ | | $S_{22}$ | |
|---|---|---|---|---|---|---|---|
| Mag. | Ang. | Mag. | Ang. | Mag. | Ang. | Mag. | Ang. |
| 0.609 | 123.6° | 0.097 | -39.6° | 1.625 | -44.1° | 0.557 | -165.3° |

   a) Prove that the transistor **can be** conjugately matched (50Ω) for maximum gain. (**0.5p**)
   b) Which is the transducer power gain we obtain in this case (in dB)? (**0.5p**)
   b) Compute the input and output reflection coefficients (towards the source and load) needed for conjugate match. **(1p)**
   c) Design the match with single-stub matching sections (any solution). **(1p)**
   d) If for better gain you must add another transistor of the same type, design the matching section between the two amplifier stages (any solution). **(1p)**
   e) In the d) case, which of all solutions for the interstage matching section requires the least substrate area (assume T shape layout)? Explain your choice. **(2p)**

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# *SUBJECT No.4*

**Time allowed: 2 hours; All materials/equipments authorized**

Instructor, sl. Radu Damian Student: _________________________________ Grupa_______

**Note**. Except where otherwise specified, assume 50Ω reference impedance.
**Note**. Any CAD solution (Matlab, Mathcad, ADS) must be accompanied by the submission of the script/project at the end of the examination.

1. Compute the normalized admittance if the impedance is 37.3Ω + j·59.1Ω and the reference impedance is 35Ω. **(1p)**
2. Outline a Smith Chart (only the external circle and the complex plane axes) and plot the point corresponding to an admittance equal to 0.0342S + j·0.0247S. **(1p)**
3. A lossless coupler designed to work on 50Ω terminations has a coupling factor equal to 5.80dB and a isolation equal to 21.6dB. If the input power (50Ω source) is 3.25mW:
   a) Compute the isolated output power (**in dBm and μW**). **(1p)**
   b) Design an ideal ring coupler for the specified coupling factor. **(1p)**
4. A quarter wave transformer is designed to match a 27Ω load to a 50Ω feed line at 8.0GHz.
   a) Design the quarter wave transformer. **(0.5p)**
   b) If at the load in series with the 27Ω resistance we add a 1.24nH inductor compute the resulting input impedance. **(1.5p)**
5. In order to obtain an 15.30dB gain (minimum) amplifier you must connect in series two devices. You have available the four devices in the following table.

| Device | 1 | 2 | 3 | 4 |
|---|---|---|---|---|
| Gain [dB] | 6.4 | 8.1 | 8.8 | 11.6 |
| Noise Factor [dB] | 0.64 | 0.83 | 0.98 | 1.27 |

   a) Specify any two devices you can use to meet the amplifier requirements. **(0.5p)**
   b) Of all the combinations that meet the requirements, which one has the minimum noise factor? Explain your choice. **(1.5p)**

6. The scattering parameters of a transistor at 12.7 GHz are as follows:

| $S_{11}$ | | $S_{12}$ | | $S_{21}$ | | $S_{22}$ | |
|---|---|---|---|---|---|---|---|
| Mag. | Ang. | Mag. | Ang. | Mag. | Ang. | Mag. | Ang. |
| 0.640 | 148.9° | 0.090 | -30.5° | 1.726 | -19.1° | 0.550 | -147.0° |

   a) Prove that the transistor **can be** conjugately matched (50Ω) for maximum gain. (**0.5p**)
   b) Which is the transducer power gain we obtain in this case (in dB)? (**0.5p**)
   b) Compute the input and output reflection coefficients (towards the source and load) needed for conjugate match. **(1p)**
   c) Design the match with single-stub matching sections (any solution). **(1p)**
   d) If for better gain you must add another transistor of the same type, design the matching section between the two amplifier stages (any solution). **(1p)**
   e) In the d) case, which of all solutions for the interstage matching section requires the least substrate area (assume T shape layout)? Explain your choice. **(2p)**

# SUBJECT No.5

**Time allowed: 2 hours; All materials/equipments authorized**

Instructor, sl. Radu Damian Student: _________________________________ Grupa_______

**Note**. Except where otherwise specified, assume 50Ω reference impedance.
**Note**. Any CAD solution (Matlab, Mathcad, ADS) must be accompanied by the submission of the script/project at the end of the examination.

1. Compute the normalized admittance if the impedance is 47.4Ω − j·34.1Ω and the reference impedance is 85Ω. **(1p)**
2. Outline a Smith Chart (only the external circle and the complex plane axes) and plot the point corresponding to an admittance equal to 0.0142S + j·0.0265S. **(1p)**
3. A lossless coupler designed to work on 50Ω terminations has a coupling factor equal to 6.60dB and a isolation equal to 20.0dB. If the input power (50Ω source) is 2.30mW:
   a) Compute the isolated output power (**<u>in dBm and μW</u>**). **(1p)**
   b) Design an ideal coupled line coupler for the specified coupling factor. **(1p)**
4. A quarter wave transformer is designed to match a 31Ω load to a 50Ω feed line at 8.5GHz.
   a) Design the quarter wave transformer. **(0.5p)**
   b) If at the load in series with the 31Ω resistance we add a 0.41pF capacitor compute the resulting input impedance. **(1.5p)**
5. In order to obtain an 16.75dB gain (minimum) amplifier you must connect in series two devices. You have available the four devices in the following table.

| **Device** | **1** | **2** | **3** | **4** |
|---|---|---|---|---|
| Gain [dB] | 6.7 | 7.4 | 9.5 | 10.4 |
| Noise Factor [dB] | 0.59 | 0.70 | 1.03 | 1.19 |

   a) Specify any two devices you can use to meet the amplifier requirements. **(0.5p)**
   b) Of all the combinations that meet the requirements, which one has the minimum noise factor? Explain your choice. **(1.5p)**
6. The scattering parameters of a transistor at 13.6 GHz are as follows:

| $S_{11}$ | | $S_{12}$ | | $S_{21}$ | | $S_{22}$ | |
|---|---|---|---|---|---|---|---|
| Mag. | Ang. | Mag. | Ang. | Mag. | Ang. | Mag. | Ang. |
| 0.634 | 137.2° | 0.090 | -33.2° | 1.675 | -30.2° | 0.550 | -155.4° |

   a) Prove that the transistor **<u>can be</u>** conjugately matched (50Ω) for maximum gain. (**0.5p**)
   b) Which is the transducer power gain we obtain in this case (in dB)? (**0.5p**)
   b) Compute the input and output reflection coefficients (towards the source and load) needed for conjugate match. **(1p)**
   c) Design the match with single-stub matching sections (any solution). **(1p)**
   d) If for better gain you must add another transistor of the same type, design the matching section between the two amplifier stages (any solution). **(1p)**
   e) In the d) case, which of all solutions for the interstage matching section requires the least substrate area (assume T shape layout)? Explain your choice. **(2p)**

# *S U B J E C T   N o . 6*

**Time allowed: 2 hours; All materials/equipments authorized**

Instructor, sl. Radu Damian        Student: ________________________________   Grupa_______

**Note**. Except where otherwise specified, assume 50Ω reference impedance.
**Note**. Any CAD solution (Matlab, Mathcad, ADS) must be accompanied by the submission of the script/project at the end of the examination.

1. Compute the normalized admittance if the impedance is 42.8Ω + j·30.4Ω and the reference impedance is 75Ω. **(1p)**
2. Outline a Smith Chart (only the external circle and the complex plane axes) and plot the point corresponding to an admittance equal to 0.0200S + j·0.0115S. **(1p)**
3. A lossless coupler designed to work on 50Ω terminations has a coupling factor equal to 6.70dB and a directivity equal to 22.7dB. If the input power (50Ω source) is 2.60mW:
   a) Compute the isolated output power (**in dBm and μW**). **(1p)**
   b) Design an ideal coupled line coupler for the specified coupling factor. **(1p)**
4. A quarter wave transformer is designed to match a 27Ω load to a 50Ω feed line at 6.5GHz.
   a) Design the quarter wave transformer. **(0.5p)**
   b) If at the load in parallel with the 27Ω resistance we add a 0.48pF capacitor compute the resulting input impedance. **(1.5p)**
5. In order to obtain an 15.35dB gain (minimum) amplifier you must connect in series two devices. You have available the four devices in the following table.

| **Device** | **1** | **2** | **3** | **4** |
|---|---|---|---|---|
| Gain [dB] | 6.2 | 8.6 | 8.5 | 10.7 |
| Noise Factor [dB] | 0.68 | 0.84 | 1.09 | 1.21 |

   a) Specify any two devices you can use to meet the amplifier requirements. **(0.5p)**
   b) Of all the combinations that meet the requirements, which one has the minimum noise factor? Explain your choice. **(1.5p)**

6. The scattering parameters of a transistor at 14.1 GHz are as follows:

| $S_{11}$ | | $S_{12}$ | | $S_{21}$ | | $S_{22}$ | |
|---|---|---|---|---|---|---|---|
| Mag. | Ang. | Mag. | Ang. | Mag. | Ang. | Mag. | Ang. |
| 0.627 | 130.8° | 0.091 | -34.8° | 1.648 | -36.3° | 0.551 | -159.9° |

   a) Prove that the transistor **can be** conjugately matched (50Ω) for maximum gain. (**0.5p**)
   b) Which is the transducer power gain we obtain in this case (in dB)? (**0.5p**)
   b) Compute the input and output reflection coefficients (towards the source and load) needed for conjugate match. **(1p)**
   c) Design the match with single-stub matching sections (any solution). **(1p)**
   d) If for better gain you must add another transistor of the same type, design the matching section between the two amplifier stages (any solution). **(1p)**
   e) In the d) case, which of all solutions for the interstage matching section requires the least substrate area (assume T shape layout)? Explain your choice. **(2p)**

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# SUBJECT No.7

**Time allowed: 2 hours; All materials/equipments authorized**

Instructor, sl. Radu Damian Student: _________________________________ Grupa_______

**Note**. Except where otherwise specified, assume 50Ω reference impedance.
**Note**. Any CAD solution (Matlab, Mathcad, ADS) must be accompanied by the submission of the script/project at the end of the examination.

1. Compute the normalized admittance if the impedance is 51.9Ω − j·49.5Ω and the reference impedance is 30Ω. **(1p)**
2. Outline a Smith Chart (only the external circle and the complex plane axes) and plot the point corresponding to an admittance equal to 0.0327S + j·0.0259S. **(1p)**
3. A lossless coupler designed to work on 50Ω terminations has a coupling factor equal to 5.00dB and a isolation equal to 24.0dB. If the input power (50Ω source) is 1.30mW:
   a) Compute the isolated output power (**in dBm and μW**). **(1p)**
   b) Design an ideal ring coupler for the specified coupling factor. **(1p)**
4. A quarter wave transformer is designed to match a 31Ω load to a 50Ω feed line at 9.3GHz.
   a) Design the quarter wave transformer. **(0.5p)**
   b) If at the load in parallel with the 31Ω resistance we add a 0.26pF capacitor compute the resulting input impedance. **(1.5p)**
5. In order to obtain an 15.65dB gain (minimum) amplifier you must connect in series two devices. You have available the four devices in the following table.

| **Device** | **1** | **2** | **3** | **4** |
|---|---|---|---|---|
| Gain [dB] | 5.7 | 7.3 | 9.8 | 10.6 |
| Noise Factor [dB] | 0.53 | 0.71 | 0.97 | 1.29 |

   a) Specify any two devices you can use to meet the amplifier requirements. **(0.5p)**
   b) Of all the combinations that meet the requirements, which one has the minimum noise factor? Explain your choice. **(1.5p)**
6. The scattering parameters of a transistor at 8.9 GHz are as follows:

| $S_{11}$ | | $S_{12}$ | | $S_{21}$ | | $S_{22}$ | |
|---|---|---|---|---|---|---|---|
| Mag. | Ang. | Mag. | Ang. | Mag. | Ang. | Mag. | Ang. |
| 0.653 | -162.7° | 0.070 | 3.6° | 2.525 | 29.4° | 0.519 | -107.1° |

   a) Prove that the transistor **can be** conjugately matched (50Ω) for maximum gain. (**0.5p**)
   b) Which is the transducer power gain we obtain in this case (in dB)? (**0.5p**)
   b) Compute the input and output reflection coefficients (towards the source and load) needed for conjugate match. **(1p)**
   c) Design the match with single-stub matching sections (any solution). **(1p)**
   d) If for better gain you must add another transistor of the same type, design the matching section between the two amplifier stages (any solution). **(1p)**
   e) In the d) case, which of all solutions for the interstage matching section requires the least substrate area (assume T shape layout)? Explain your choice. **(2p)**

# *S U B J E C T N o . 8*

**Time allowed: 2 hours; All materials/equipments authorized**

Instructor, sl. Radu Damian Student: _________________________________ Grupa_______

**Note**. Except where otherwise specified, assume 50Ω reference impedance.
**Note**. Any CAD solution (Matlab, Mathcad, ADS) must be accompanied by the submission of the script/project at the end of the examination.

1. Compute the normalized admittance if the impedance is 62.2Ω − j·51.2Ω and the reference impedance is 80Ω. **(1p)**
2. Outline a Smith Chart (only the external circle and the complex plane axes) and plot the point corresponding to an admittance equal to 0.0325S − j·0.0195S. **(1p)**
3. A lossless coupler designed to work on 50Ω terminations has a coupling factor equal to 6.95dB and a directivity equal to 21.3dB. If the input power (50Ω source) is 2.15mW:
   a) Compute the isolated output power (**in dBm and μW**). **(1p)**
   b) Design an ideal coupled line coupler for the specified coupling factor. **(1p)**
4. A quarter wave transformer is designed to match a 41Ω load to a 50Ω feed line at 8.1GHz.
   a) Design the quarter wave transformer. **(0.5p)**
   b) If at the load in series with the 41Ω resistance we add a 0.88nH inductor compute the resulting input impedance. **(1.5p)**
5. In order to obtain an 16.10dB gain (minimum) amplifier you must connect in series two devices. You have available the four devices in the following table.

| **Device** | **1** | **2** | **3** | **4** |
|---|---|---|---|---|
| Gain [dB] | 6.5 | 7.5 | 9.1 | 10.2 |
| Noise Factor [dB] | 0.51 | 0.83 | 1.03 | 1.17 |

   a) Specify any two devices you can use to meet the amplifier requirements. **(0.5p)**
   b) Of all the combinations that meet the requirements, which one has the minimum noise factor? Explain your choice. **(1.5p)**

6. The scattering parameters of a transistor at 10.5 GHz are as follows:

| $S_{11}$ | | $S_{12}$ | | $S_{21}$ | | $S_{22}$ | |
|---|---|---|---|---|---|---|---|
| Mag. | Ang. | Mag. | Ang. | Mag. | Ang. | Mag. | Ang. |
| 0.605 | 175.5° | 0.080 | -3.5° | 2.318 | 8.5° | 0.520 | -113.5° |

   a) Prove that the transistor **can be** conjugately matched (50Ω) for maximum gain. (**0.5p**)
   b) Which is the transducer power gain we obtain in this case (in dB)? (**0.5p**)
   b) Compute the input and output reflection coefficients (towards the source and load) needed for conjugate match. **(1p)**
   c) Design the match with single-stub matching sections (any solution). **(1p)**
   d) If for better gain you must add another transistor of the same type, design the matching section between the two amplifier stages (any solution). **(1p)**
   e) In the d) case, which of all solutions for the interstage matching section requires the least substrate area (assume T shape layout)? Explain your choice. **(2p)**

# S U B J E C T No. 9

**Time allowed: 2 hours; All materials/equipments authorized**

Instructor, sl. Radu Damian Student: _________________________________ Grupa_______

**Note**. Except where otherwise specified, assume 50Ω reference impedance.

**Note**. Any CAD solution (Matlab, Mathcad, ADS) must be accompanied by the submission of the script/project at the end of the examination.

1. Compute the normalized admittance if the impedance is 40.8Ω + j·68.5Ω and the reference impedance is 70Ω. **(1p)**
2. Outline a Smith Chart (only the external circle and the complex plane axes) and plot the point corresponding to an admittance equal to 0.0236S + j·0.0112S. **(1p)**
3. A lossless coupler designed to work on 50Ω terminations has a coupling factor equal to 4.85dB and a isolation equal to 22.0dB. If the input power (50Ω source) is 3.25mW:
   a) Compute the isolated output power (**in dBm and μW**). **(1p)**
   b) Design an ideal coupled line coupler for the specified coupling factor. **(1p)**
4. A quarter wave transformer is designed to match a 56Ω load to a 50Ω feed line at 9.8GHz.
   a) Design the quarter wave transformer. **(0.5p)**
   b) If at the load in series with the 56Ω resistance we add a 1.05nH inductor compute the resulting input impedance. **(1.5p)**
5. In order to obtain an 15.35dB gain (minimum) amplifier you must connect in series two devices. You have available the four devices in the following table.

| **Device** | **1** | **2** | **3** | **4** |
|---|---|---|---|---|
| Gain [dB] | 5.4 | 8.1 | 9.9 | 10.3 |
| Noise Factor [dB] | 0.64 | 0.87 | 1.01 | 1.18 |

   a) Specify any two devices you can use to meet the amplifier requirements. **(0.5p)**
   b) Of all the combinations that meet the requirements, which one has the minimum noise factor? Explain your choice. **(1.5p)**

6. The scattering parameters of a transistor at 8.8 GHz are as follows:

| $S_{11}$ | | $S_{12}$ | | $S_{21}$ | | $S_{22}$ | |
|---|---|---|---|---|---|---|---|
| Mag. | Ang. | Mag. | Ang. | Mag. | Ang. | Mag. | Ang. |
| 0.656 | -161.4° | 0.070 | 4.2° | 2.542 | 30.8° | 0.518 | -105.2° |

   a) Prove that the transistor **can be** conjugately matched (50Ω) for maximum gain. (**0.5p**)
   b) Which is the transducer power gain we obtain in this case (in dB)? (**0.5p**)
   b) Compute the input and output reflection coefficients (towards the source and load) needed for conjugate match. **(1p)**
   c) Design the match with single-stub matching sections (any solution). **(1p)**
   d) If for better gain you must add another transistor of the same type, design the matching section between the two amplifier stages (any solution). **(1p)**
   e) In the d) case, which of all solutions for the interstage matching section requires the least substrate area (assume T shape layout)? Explain your choice. **(2p)**

# *S U B J E C T  N o . 1 0*

**Time allowed: 2 hours; All materials/equipments authorized**

Instructor, sl. Radu Damian Student: _________________________________ Grupa_______

**Note**. Except where otherwise specified, assume 50Ω reference impedance.
**Note**. Any CAD solution (Matlab, Mathcad, ADS) must be accompanied by the submission of the script/project at the end of the examination.

1. Compute the normalized admittance if the impedance is 56.3Ω + j·57.9Ω and the reference impedance is 80Ω. **(1p)**
2. Outline a Smith Chart (only the external circle and the complex plane axes) and plot the point corresponding to an admittance equal to 0.0216S + j·0.0204S. **(1p)**
3. A lossless coupler designed to work on 50Ω terminations has a coupling factor equal to 4.05dB and a directivity equal to 20.7dB. If the input power (50Ω source) is 2.10mW:
   a) Compute the isolated output power (**in dBm and μW**). **(1p)**
   b) Design an ideal coupled line coupler for the specified coupling factor. **(1p)**
4. A quarter wave transformer is designed to match a 74Ω load to a 50Ω feed line at 8.8GHz.
   a) Design the quarter wave transformer. **(0.5p)**
   b) If at the load in parallel with the 74Ω resistance we add a 0.30pF capacitor compute the resulting input impedance. **(1.5p)**
5. In order to obtain an 16.35dB gain (minimum) amplifier you must connect in series two devices. You have available the four devices in the following table.

| **Device** | **1** | **2** | **3** | **4** |
|---|---|---|---|---|
| Gain [dB] | 6.0 | 8.7 | 9.3 | 10.8 |
| Noise Factor [dB] | 0.57 | 0.77 | 0.98 | 1.24 |

   a) Specify any two devices you can use to meet the amplifier requirements. **(0.5p)**
   b) Of all the combinations that meet the requirements, which one has the minimum noise factor? Explain your choice. **(1.5p)**

6. The scattering parameters of a transistor at 14.3 GHz are as follows:

| $S_{11}$ | | $S_{12}$ | | $S_{21}$ | | $S_{22}$ | |
|---|---|---|---|---|---|---|---|
| Mag. | Ang. | Mag. | Ang. | Mag. | Ang. | Mag. | Ang. |
| 0.621 | 128.4° | 0.093 | -36.4° | 1.641 | -38.9° | 0.553 | -161.7° |

   a) Prove that the transistor **can be** conjugately matched (50Ω) for maximum gain. (**0.5p**)
   b) Which is the transducer power gain we obtain in this case (in dB)? (**0.5p**)
   b) Compute the input and output reflection coefficients (towards the source and load) needed for conjugate match. **(1p)**
   c) Design the match with single-stub matching sections (any solution). **(1p)**
   d) If for better gain you must add another transistor of the same type, design the matching section between the two amplifier stages (any solution). **(1p)**
   e) In the d) case, which of all solutions for the interstage matching section requires the least substrate area (assume T shape layout)? Explain your choice. **(2p)**

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# *SUBJECT No.11*

**Time allowed: 2 hours; All materials/equipments authorized**

Instructor, sl. Radu Damian Student: __________________________________ Grupa_______

**Note**. Except where otherwise specified, assume 50Ω reference impedance.
**Note**. Any CAD solution (Matlab, Mathcad, ADS) must be accompanied by the submission of the script/project at the end of the examination.

1. Compute the normalized admittance if the impedance is 43.8Ω + j·55.5Ω and the reference impedance is 45Ω. **(1p)**
2. Outline a Smith Chart (only the external circle and the complex plane axes) and plot the point corresponding to an admittance equal to 0.0297S + j·0.0108S. **(1p)**
3. A lossless coupler designed to work on 50Ω terminations has a coupling factor equal to 6.75dB and a isolation equal to 22.8dB. If the input power (50Ω source) is 3.60mW:
   a) Compute the isolated output power (**in dBm and μW**). **(1p)**
   b) Design an ideal quadrature coupler for the specified coupling factor. **(1p)**
4. A quarter wave transformer is designed to match a 54Ω load to a 50Ω feed line at 7.7GHz.
   a) Design the quarter wave transformer. **(0.5p)**
   b) If at the load in series with the 54Ω resistance we add a 0.49pF capacitor compute the resulting input impedance. **(1.5p)**
5. In order to obtain an 15.05dB gain (minimum) amplifier you must connect in series two devices. You have available the four devices in the following table.

| **Device** | **1** | **2** | **3** | **4** |
|---|---|---|---|---|
| Gain [dB] | 6.6 | 7.5 | 8.1 | 11.7 |
| Noise Factor [dB] | 0.50 | 0.88 | 1.01 | 1.15 |

   a) Specify any two devices you can use to meet the amplifier requirements. **(0.5p)**
   b) Of all the combinations that meet the requirements, which one has the minimum noise factor? Explain your choice. **(1.5p)**
6. The scattering parameters of a transistor at 13.9 GHz are as follows:

| $S_{11}$ | | $S_{12}$ | | $S_{21}$ | | $S_{22}$ | |
|---|---|---|---|---|---|---|---|
| Mag. | Ang. | Mag. | Ang. | Mag. | Ang. | Mag. | Ang. |
| 0.631 | 133.3° | 0.090 | -33.8° | 1.658 | -33.8° | 0.550 | -158.1° |

   a) Prove that the transistor **can be** conjugately matched (50Ω) for maximum gain. (**0.5p**)
   b) Which is the transducer power gain we obtain in this case (in dB)? (**0.5p**)
   b) Compute the input and output reflection coefficients (towards the source and load) needed for conjugate match. **(1p)**
   c) Design the match with single-stub matching sections (any solution). **(1p)**
   d) If for better gain you must add another transistor of the same type, design the matching section between the two amplifier stages (any solution). **(1p)**
   e) In the d) case, which of all solutions for the interstage matching section requires the least substrate area (assume T shape layout)? Explain your choice. **(2p)**

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# *S U B J E C T   N o . 1 2*

**Time allowed: 2 hours; All materials/equipments authorized**

Instructor, sl. Radu Damian        Student: _________________________________  Grupa_______

**Note**. Except where otherwise specified, assume 50Ω reference impedance.
**Note**. Any CAD solution (Matlab, Mathcad, ADS) must be accompanied by the submission of the script/project at the end of the examination.

1. Compute the normalized admittance if the impedance is 41.7Ω + j·61.5Ω and the reference impedance is 70Ω. **(1p)**
2. Outline a Smith Chart (only the external circle and the complex plane axes) and plot the point corresponding to an admittance equal to 0.0379S − j·0.0114S. **(1p)**
3. A lossless coupler designed to work on 50Ω terminations has a coupling factor equal to 6.25dB and a directivity equal to 23.7dB. If the input power (50Ω source) is 1.50mW:
   a) Compute the isolated output power (**in dBm and μW**). **(1p)**
   b) Design an ideal quadrature coupler for the specified coupling factor. **(1p)**
4. A quarter wave transformer is designed to match a 51Ω load to a 50Ω feed line at 9.2GHz.
   a) Design the quarter wave transformer. **(0.5p)**
   b) If at the load in parallel with the 51Ω resistance we add a 0.80nH inductor compute the resulting input impedance. **(1.5p)**
5. In order to obtain an 15.25dB gain (minimum) amplifier you must connect in series two devices. You have available the four devices in the following table.

| **Device** | **1** | **2** | **3** | **4** |
|---|---|---|---|---|
| Gain [dB] | 6.9 | 7.7 | 8.3 | 10.8 |
| Noise Factor [dB] | 0.62 | 0.88 | 1.02 | 1.12 |

   a) Specify any two devices you can use to meet the amplifier requirements. **(0.5p)**
   b) Of all the combinations that meet the requirements, which one has the minimum noise factor? Explain your choice. **(1.5p)**

6. The scattering parameters of a transistor at 14.8 GHz are as follows:

| $S_{11}$ | | $S_{12}$ | | $S_{21}$ | | $S_{22}$ | |
|---|---|---|---|---|---|---|---|
| Mag. | Ang. | Mag. | Ang. | Mag. | Ang. | Mag. | Ang. |
| 0.606 | 122.4° | 0.098 | -40.4° | 1.622 | -45.4° | 0.558 | -166.2° |

   a) Prove that the transistor **can be** conjugately matched (50Ω) for maximum gain. (**0.5p**)
   b) Which is the transducer power gain we obtain in this case (in dB)? (**0.5p**)
   b) Compute the input and output reflection coefficients (towards the source and load) needed for conjugate match. **(1p)**
   c) Design the match with single-stub matching sections (any solution). **(1p)**
   d) If for better gain you must add another transistor of the same type, design the matching section between the two amplifier stages (any solution). **(1p)**
   e) In the d) case, which of all solutions for the interstage matching section requires the least substrate area (assume T shape layout)? Explain your choice. **(2p)**

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# *S U B J E C T N o . 1 3*

**Time allowed: 2 hours; All materials/equipments authorized**

Instructor, sl. Radu Damian Student: __________________________________ Grupa_______

**Note**. Except where otherwise specified, assume 50Ω reference impedance.
**Note**. Any CAD solution (Matlab, Mathcad, ADS) must be accompanied by the submission of the script/project at the end of the examination.

1. Compute the normalized admittance if the impedance is 60.6Ω − j·60.9Ω and the reference impedance is 60Ω. **(1p)**
2. Outline a Smith Chart (only the external circle and the complex plane axes) and plot the point corresponding to an admittance equal to 0.0283S + j·0.0144S. **(1p)**
3. A lossless coupler designed to work on 50Ω terminations has a coupling factor equal to 4.25dB and a isolation equal to 23.5dB. If the input power (50Ω source) is 3.15mW:
   a) Compute the isolated output power (**in dBm and μW**). **(1p)**
   b) Design an ideal coupled line coupler for the specified coupling factor. **(1p)**
4. A quarter wave transformer is designed to match a 29Ω load to a 50Ω feed line at 8.4GHz.
   a) Design the quarter wave transformer. **(0.5p)**
   b) If at the load in series with the 29Ω resistance we add a 0.60nH inductor compute the resulting input impedance. **(1.5p)**
5. In order to obtain an 17.50dB gain (minimum) amplifier you must connect in series two devices. You have available the four devices in the following table.

| **Device** | **1** | **2** | **3** | **4** |
|---|---|---|---|---|
| Gain [dB] | 6.1 | 8.8 | 9.8 | 11.6 |
| Noise Factor [dB] | 0.52 | 0.85 | 1.06 | 1.10 |

   a) Specify any two devices you can use to meet the amplifier requirements. **(0.5p)**
   b) Of all the combinations that meet the requirements, which one has the minimum noise factor? Explain your choice. **(1.5p)**
6. The scattering parameters of a transistor at 12.9 GHz are as follows:

| $S_{11}$ | | $S_{12}$ | | $S_{21}$ | | $S_{22}$ | |
|---|---|---|---|---|---|---|---|
| Mag. | Ang. | Mag. | Ang. | Mag. | Ang. | Mag. | Ang. |
| 0.640 | 146.3° | 0.090 | -31.5° | 1.715 | -21.7° | 0.550 | -149.0° |

   a) Prove that the transistor **can be** conjugately matched (50Ω) for maximum gain. (**0.5p**)
   b) Which is the transducer power gain we obtain in this case (in dB)? (**0.5p**)
   b) Compute the input and output reflection coefficients (towards the source and load) needed for conjugate match. **(1p)**
   c) Design the match with single-stub matching sections (any solution). **(1p)**
   d) If for better gain you must add another transistor of the same type, design the matching section between the two amplifier stages (any solution). **(1p)**
   e) In the d) case, which of all solutions for the interstage matching section requires the least substrate area (assume T shape layout)? Explain your choice. **(2p)**

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# *S U B J E C T  N o . 1 4*

**Time allowed: 2 hours; All materials/equipments authorized**

Instructor, sl. Radu Damian      Student: _________________________________ Grupa_______

**Note**. Except where otherwise specified, assume 50Ω reference impedance.
**Note**. Any CAD solution (Matlab, Mathcad, ADS) must be accompanied by the submission of the script/project at the end of the examination.

1. Compute the normalized admittance if the impedance is 53.9Ω − j·68.9Ω and the reference impedance is 100Ω. **(1p)**
2. Outline a Smith Chart (only the external circle and the complex plane axes) and plot the point corresponding to an admittance equal to 0.0337S − j·0.0358S. **(1p)**
3. A lossless coupler designed to work on 50Ω terminations has a coupling factor equal to 5.85dB and a isolation equal to 22.8dB. If the input power (50Ω source) is 2.90mW:
   a) Compute the isolated output power (**<u>in dBm and µW</u>**). **(1p)**
   b) Design an ideal quadrature coupler for the specified coupling factor. **(1p)**
4. A quarter wave transformer is designed to match a 29Ω load to a 50Ω feed line at 7.1GHz.
   a) Design the quarter wave transformer. **(0.5p)**
   b) If at the load in series with the 29Ω resistance we add a 0.46pF capacitor compute the resulting input impedance. **(1.5p)**
5. In order to obtain an 17.00dB gain (minimum) amplifier you must connect in series two devices. You have available the four devices in the following table.

| **Device** | **1** | **2** | **3** | **4** |
|---|---|---|---|---|
| Gain [dB] | 6.5 | 8.8 | 9.7 | 10.6 |
| Noise Factor [dB] | 0.65 | 0.73 | 1.05 | 1.14 |

   a) Specify any two devices you can use to meet the amplifier requirements. **(0.5p)**
   b) Of all the combinations that meet the requirements, which one has the minimum noise factor? Explain your choice. **(1.5p)**
6. The scattering parameters of a transistor at 13.3 GHz are as follows:

| $S_{11}$ | | $S_{12}$ | | $S_{21}$ | | $S_{22}$ | |
|---|---|---|---|---|---|---|---|
| Mag. | Ang. | Mag. | Ang. | Mag. | Ang. | Mag. | Ang. |
| 0.637 | 141.1° | 0.090 | -32.6° | 1.692 | -26.6° | 0.550 | -152.7° |

   a) Prove that the transistor **<u>can be</u>** conjugately matched (50Ω) for maximum gain. (**0.5p**)
   b) Which is the transducer power gain we obtain in this case (in dB)? (**0.5p**)
   b) Compute the input and output reflection coefficients (towards the source and load) needed for conjugate match. **(1p)**
   c) Design the match with single-stub matching sections (any solution). **(1p)**
   d) If for better gain you must add another transistor of the same type, design the matching section between the two amplifier stages (any solution). **(1p)**
   e) In the d) case, which of all solutions for the interstage matching section requires the least substrate area (assume T shape layout)? Explain your choice. **(2p)**

# S U B J E C T  N o . 1 5

**Time allowed: 2 hours; All materials/equipments authorized**

Instructor, sl. Radu Damian        Student: _________________________________   Grupa_______

**Note**. Except where otherwise specified, assume 50Ω reference impedance.
**Note**. Any CAD solution (Matlab, Mathcad, ADS) must be accompanied by the submission of the script/project at the end of the examination.

1. Compute the normalized admittance if the impedance is 54.6Ω + j·52.3Ω and the reference impedance is 100Ω. **(1p)**
2. Outline a Smith Chart (only the external circle and the complex plane axes) and plot the point corresponding to an admittance equal to 0.0240S + j·0.0187S. **(1p)**
3. A lossless coupler designed to work on 50Ω terminations has a coupling factor equal to 6.65dB and a isolation equal to 21.1dB. If the input power (50Ω source) is 2.05mW:
   a) Compute the isolated output power (**in dBm and μW**). **(1p)**
   b) Design an ideal coupled line coupler for the specified coupling factor. **(1p)**
4. A quarter wave transformer is designed to match a 59Ω load to a 50Ω feed line at 9.0GHz.
   a) Design the quarter wave transformer. **(0.5p)**
   b) If at the load in parallel with the 59Ω resistance we add a 0.91nH inductor compute the resulting input impedance. **(1.5p)**
5. In order to obtain an 16.25dB gain (minimum) amplifier you must connect in series two devices. You have available the four devices in the following table.

| **Device** | **1** | **2** | **3** | **4** |
|---|---|---|---|---|
| Gain [dB] | 6.7 | 8.9 | 9.5 | 10.0 |
| Noise Factor [dB] | 0.66 | 0.75 | 0.99 | 1.13 |

   a) Specify any two devices you can use to meet the amplifier requirements. **(0.5p)**
   b) Of all the combinations that meet the requirements, which one has the minimum noise factor? Explain your choice. **(1.5p)**
6. The scattering parameters of a transistor at 14.0 GHz are as follows:

| $S_{11}$ | | $S_{12}$ | | $S_{21}$ | | $S_{22}$ | |
|---|---|---|---|---|---|---|---|
| Mag. | Ang. | Mag. | Ang. | Mag. | Ang. | Mag. | Ang. |
| 0.630 | 132.0° | 0.090 | -34.0° | 1.652 | -35.0° | 0.550 | -159.0° |

   a) Prove that the transistor **can be** conjugately matched (50Ω) for maximum gain. (**0.5p**)
   b) Which is the transducer power gain we obtain in this case (in dB)? (**0.5p**)
   b) Compute the input and output reflection coefficients (towards the source and load) needed for conjugate match. **(1p)**
   c) Design the match with single-stub matching sections (any solution). **(1p)**
   d) If for better gain you must add another transistor of the same type, design the matching section between the two amplifier stages (any solution). **(1p)**
   e) In the d) case, which of all solutions for the interstage matching section requires the least substrate area (assume T shape layout)? Explain your choice. **(2p)**

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# SUBJECT No.16

**Time allowed: 2 hours; All materials/equipments authorized**

Instructor, sl. Radu Damian Student: _________________________________ Grupa_______

**Note**. Except where otherwise specified, assume 50Ω reference impedance.
**Note**. Any CAD solution (Matlab, Mathcad, ADS) must be accompanied by the submission of the script/project at the end of the examination.

1. Compute the normalized admittance if the impedance is 68.4Ω − j·60.3Ω and the reference impedance is 70Ω. **(1p)**
2. Outline a Smith Chart (only the external circle and the complex plane axes) and plot the point corresponding to an admittance equal to 0.0210S + j·0.0388S. **(1p)**
3. A lossless coupler designed to work on 50Ω terminations has a coupling factor equal to 4.45dB and a directivity equal to 21.0dB. If the input power (50Ω source) is 2.05mW:
   a) Compute the isolated output power (**in dBm and μW**). **(1p)**
   b) Design an ideal coupled line coupler for the specified coupling factor. **(1p)**
4. A quarter wave transformer is designed to match a 72Ω load to a 50Ω feed line at 9.0GHz.
   a) Design the quarter wave transformer. **(0.5p)**
   b) If at the load in series with the 72Ω resistance we add a 0.67nH inductor compute the resulting input impedance. **(1.5p)**
5. In order to obtain an 15.80dB gain (minimum) amplifier you must connect in series two devices. You have available the four devices in the following table.

| **Device** | **1** | **2** | **3** | **4** |
|---|---|---|---|---|
| Gain [dB] | 5.2 | 7.7 | 8.9 | 11.0 |
| Noise Factor [dB] | 0.60 | 0.77 | 1.01 | 1.12 |

   a) Specify any two devices you can use to meet the amplifier requirements. **(0.5p)**
   b) Of all the combinations that meet the requirements, which one has the minimum noise factor? Explain your choice. **(1.5p)**
6. The scattering parameters of a transistor at 10.7 GHz are as follows:

| $S_{11}$ | | $S_{12}$ | | $S_{21}$ | | $S_{22}$ | |
|---|---|---|---|---|---|---|---|
| Mag. | Ang. | Mag. | Ang. | Mag. | Ang. | Mag. | Ang. |
| 0.599 | 172.5° | 0.080 | -4.5° | 2.294 | 5.9° | 0.520 | -115.3° |

   a) Prove that the transistor **can be** conjugately matched (50Ω) for maximum gain. (**0.5p**)
   b) Which is the transducer power gain we obtain in this case (in dB)? (**0.5p**)
   b) Compute the input and output reflection coefficients (towards the source and load) needed for conjugate match. **(1p)**
   c) Design the match with single-stub matching sections (any solution). **(1p)**
   d) If for better gain you must add another transistor of the same type, design the matching section between the two amplifier stages (any solution). **(1p)**
   e) In the d) case, which of all solutions for the interstage matching section requires the least substrate area (assume T shape layout)? Explain your choice. **(2p)**

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# S U B J E C T N o . 1 7

**Time allowed: 2 hours; All materials/equipments authorized**

Instructor, sl. Radu Damian Student: _________________________________ Grupa_______

**Note**. Except where otherwise specified, assume 50Ω reference impedance.
**Note**. Any CAD solution (Matlab, Mathcad, ADS) must be accompanied by the submission of the script/project at the end of the examination.

1. Compute the normalized admittance if the impedance is 41.2Ω + j·37.4Ω and the reference impedance is 90Ω. **(1p)**
2. Outline a Smith Chart (only the external circle and the complex plane axes) and plot the point corresponding to an admittance equal to 0.0195S + j·0.0299S. **(1p)**
3. A lossless coupler designed to work on 50Ω terminations has a coupling factor equal to 6.65dB and a directivity equal to 22.3dB. If the input power (50Ω source) is 3.10mW:
   a) Compute the isolated output power (**in dBm and μW**). **(1p)**
   b) Design an ideal quadrature coupler for the specified coupling factor. **(1p)**
4. A quarter wave transformer is designed to match a 50Ω load to a 50Ω feed line at 9.6GHz.
   a) Design the quarter wave transformer. **(0.5p)**
   b) If at the load in series with the 50Ω resistance we add a 0.78nH inductor compute the resulting input impedance. **(1.5p)**
5. In order to obtain an 14.95dB gain (minimum) amplifier you must connect in series two devices. You have available the four devices in the following table.

| **Device** | **1** | **2** | **3** | **4** |
|---|---|---|---|---|
| Gain [dB] | 5.2 | 8.7 | 8.0 | 11.0 |
| Noise Factor [dB] | 0.53 | 0.75 | 1.05 | 1.22 |

   a) Specify any two devices you can use to meet the amplifier requirements. **(0.5p)**
   b) Of all the combinations that meet the requirements, which one has the minimum noise factor? Explain your choice. **(1.5p)**
6. The scattering parameters of a transistor at 14.9 GHz are as follows:

| $S_{11}$ | | $S_{12}$ | | $S_{21}$ | | $S_{22}$ | |
|---|---|---|---|---|---|---|---|
| Mag. | Ang. | Mag. | Ang. | Mag. | Ang. | Mag. | Ang. |
| 0.603 | 121.2° | 0.099 | -41.2° | 1.618 | -46.7° | 0.559 | -167.1° |

   a) Prove that the transistor **can be** conjugately matched (50Ω) for maximum gain. (**0.5p**)
   b) Which is the transducer power gain we obtain in this case (in dB)? (**0.5p**)
   b) Compute the input and output reflection coefficients (towards the source and load) needed for conjugate match. **(1p)**
   c) Design the match with single-stub matching sections (any solution). **(1p)**
   d) If for better gain you must add another transistor of the same type, design the matching section between the two amplifier stages (any solution). **(1p)**
   e) In the d) case, which of all solutions for the interstage matching section requires the least substrate area (assume T shape layout)? Explain your choice. **(2p)**

# S U B J E C T N o . 1 8

**Time allowed: 2 hours; All materials/equipments authorized**

Instructor, sl. Radu Damian Student: ________________________________ Grupa_______

**Note**. Except where otherwise specified, assume 50Ω reference impedance.
**Note**. Any CAD solution (Matlab, Mathcad, ADS) must be accompanied by the submission of the script/project at the end of the examination.

1. Compute the normalized admittance if the impedance is 69.2Ω − j·53.4Ω and the reference impedance is 30Ω. **(1p)**
2. Outline a Smith Chart (only the external circle and the complex plane axes) and plot the point corresponding to an admittance equal to 0.0133S − j·0.0316S. **(1p)**
3. A lossless coupler designed to work on 50Ω terminations has a coupling factor equal to 6.50dB and a directivity equal to 24.6dB. If the input power (50Ω source) is 3.45mW:
   a) Compute the isolated output power (**in dBm and μW**). **(1p)**
   b) Design an ideal ring coupler for the specified coupling factor. **(1p)**
4. A quarter wave transformer is designed to match a 71Ω load to a 50Ω feed line at 9.9GHz.
   a) Design the quarter wave transformer. **(0.5p)**
   b) If at the load in parallel with the 71Ω resistance we add a 0.42pF capacitor compute the resulting input impedance. **(1.5p)**
5. In order to obtain an 14.75dB gain (minimum) amplifier you must connect in series two devices. You have available the four devices in the following table.

| **Device** | **1** | **2** | **3** | **4** |
|---|---|---|---|---|
| Gain [dB] | 5.9 | 8.6 | 8.8 | 11.1 |
| Noise Factor [dB] | 0.55 | 0.86 | 0.90 | 1.13 |

   a) Specify any two devices you can use to meet the amplifier requirements. **(0.5p)**
   b) Of all the combinations that meet the requirements, which one has the minimum noise factor? Explain your choice. **(1.5p)**

6. The scattering parameters of a transistor at 10.4 GHz are as follows:

| $S_{11}$ | | $S_{12}$ | | $S_{21}$ | | $S_{22}$ | |
|---|---|---|---|---|---|---|---|
| Mag. | Ang. | Mag. | Ang. | Mag. | Ang. | Mag. | Ang. |
| 0.608 | 177.0° | 0.080 | -3.0° | 2.330 | 9.8° | 0.520 | -112.6° |

   a) Prove that the transistor **can be** conjugately matched (50Ω) for maximum gain. (**0.5p**)
   b) Which is the transducer power gain we obtain in this case (in dB)? (**0.5p**)
   b) Compute the input and output reflection coefficients (towards the source and load) needed for conjugate match. **(1p)**
   c) Design the match with single-stub matching sections (any solution). **(1p)**
   d) If for better gain you must add another transistor of the same type, design the matching section between the two amplifier stages (any solution). **(1p)**
   e) In the d) case, which of all solutions for the interstage matching section requires the least substrate area (assume T shape layout)? Explain your choice. **(2p)**

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# SUBJECT No.19

**Time allowed: 2 hours; All materials/equipments authorized**

Instructor, sl. Radu Damian Student: ________________________________ Grupa_______

**Note**. Except where otherwise specified, assume 50Ω reference impedance.
**Note**. Any CAD solution (Matlab, Mathcad, ADS) must be accompanied by the submission of the script/project at the end of the examination.

1. Compute the normalized admittance if the impedance is 31.2Ω − j·59.0Ω and the reference impedance is 70Ω. **(1p)**
2. Outline a Smith Chart (only the external circle and the complex plane axes) and plot the point corresponding to an admittance equal to 0.0249S + j·0.0350S. **(1p)**
3. A lossless coupler designed to work on 50Ω terminations has a coupling factor equal to 4.65dB and a directivity equal to 21.7dB. If the input power (50Ω source) is 3.30mW:
   a) Compute the isolated output power (**in dBm and μW**). **(1p)**
   b) Design an ideal ring coupler for the specified coupling factor. **(1p)**
4. A quarter wave transformer is designed to match a 74Ω load to a 50Ω feed line at 8.7GHz.
   a) Design the quarter wave transformer. **(0.5p)**
   b) If at the load in series with the 74Ω resistance we add a 0.73nH inductor compute the resulting input impedance. **(1.5p)**
5. In order to obtain an 16.30dB gain (minimum) amplifier you must connect in series two devices. You have available the four devices in the following table.

| **Device** | **1** | **2** | **3** | **4** |
|---|---|---|---|---|
| Gain [dB] | 5.0 | 8.2 | 9.4 | 11.9 |
| Noise Factor [dB] | 0.66 | 0.78 | 1.02 | 1.19 |

   a) Specify any two devices you can use to meet the amplifier requirements. **(0.5p)**
   b) Of all the combinations that meet the requirements, which one has the minimum noise factor? Explain your choice. **(1.5p)**
6. The scattering parameters of a transistor at 10.0 GHz are as follows:

| $S_{11}$ | | $S_{12}$ | | $S_{21}$ | | $S_{22}$ | |
|---|---|---|---|---|---|---|---|
| Mag. | Ang. | Mag. | Ang. | Mag. | Ang. | Mag. | Ang. |
| 0.620 | -177.0° | 0.080 | -1.0° | 2.378 | 15.0° | 0.520 | -109.0° |

   a) Prove that the transistor **can be** conjugately matched (50Ω) for maximum gain. (**0.5p**)
   b) Which is the transducer power gain we obtain in this case (in dB)? (**0.5p**)
   b) Compute the input and output reflection coefficients (towards the source and load) needed for conjugate match. **(1p)**
   c) Design the match with single-stub matching sections (any solution). **(1p)**
   d) If for better gain you must add another transistor of the same type, design the matching section between the two amplifier stages (any solution). **(1p)**
   e) In the d) case, which of all solutions for the interstage matching section requires the least substrate area (assume T shape layout)? Explain your choice. **(2p)**

# S U B J E C T N o . 2 0

**Time allowed: 2 hours; All materials/equipments authorized**

Instructor, sl. Radu Damian Student: _________________________________ Grupa_______

**Note**. Except where otherwise specified, assume 50Ω reference impedance.
**Note**. Any CAD solution (Matlab, Mathcad, ADS) must be accompanied by the submission of the script/project at the end of the examination.

1. Compute the normalized admittance if the impedance is 56.6Ω + j·36.8Ω and the reference impedance is 50Ω. **(1p)**
2. Outline a Smith Chart (only the external circle and the complex plane axes) and plot the point corresponding to an admittance equal to 0.0105S − j·0.0151S. **(1p)**
3. A lossless coupler designed to work on 50Ω terminations has a coupling factor equal to 6.60dB and a directivity equal to 24.6dB. If the input power (50Ω source) is 3.90mW:
   a) Compute the isolated output power (**in dBm and μW**). **(1p)**
   b) Design an ideal coupled line coupler for the specified coupling factor. **(1p)**
4. A quarter wave transformer is designed to match a 65Ω load to a 50Ω feed line at 9.0GHz.
   a) Design the quarter wave transformer. **(0.5p)**
   b) If at the load in series with the 65Ω resistance we add a 0.30pF capacitor compute the resulting input impedance. **(1.5p)**
5. In order to obtain an 16.85dB gain (minimum) amplifier you must connect in series two devices. You have available the four devices in the following table.

| **Device** | **1** | **2** | **3** | **4** |
|---|---|---|---|---|
| Gain [dB] | 6.1 | 7.2 | 9.9 | 11.4 |
| Noise Factor [dB] | 0.57 | 0.70 | 0.94 | 1.19 |

   a) Specify any two devices you can use to meet the amplifier requirements. **(0.5p)**
   b) Of all the combinations that meet the requirements, which one has the minimum noise factor? Explain your choice. **(1.5p)**
6. The scattering parameters of a transistor at 13.1 GHz are as follows:

| $S_{11}$ | | $S_{12}$ | | $S_{21}$ | | $S_{22}$ | |
|---|---|---|---|---|---|---|---|
| Mag. | Ang. | Mag. | Ang. | Mag. | Ang. | Mag. | Ang. |
| 0.639 | 143.7° | 0.090 | -32.2° | 1.703 | -24.2° | 0.550 | -150.9° |

   a) Prove that the transistor **can be** conjugately matched (50Ω) for maximum gain. (**0.5p**)
   b) Which is the transducer power gain we obtain in this case (in dB)? (**0.5p**)
   b) Compute the input and output reflection coefficients (towards the source and load) needed for conjugate match. **(1p)**
   c) Design the match with single-stub matching sections (any solution). **(1p)**
   d) If for better gain you must add another transistor of the same type, design the matching section between the two amplifier stages (any solution). **(1p)**
   e) In the d) case, which of all solutions for the interstage matching section requires the least substrate area (assume T shape layout)? Explain your choice. **(2p)**

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# SUBJECT No.21

**Time allowed: 2 hours; All materials/equipments authorized**

Instructor, sl. Radu Damian Student: _________________________________ Grupa_______

**Note**. Except where otherwise specified, assume 50Ω reference impedance.
**Note**. Any CAD solution (Matlab, Mathcad, ADS) must be accompanied by the submission of the script/project at the end of the examination.

1. Compute the normalized admittance if the impedance is 43.6Ω + j·37.4Ω and the reference impedance is 80Ω. **(1p)**
2. Outline a Smith Chart (only the external circle and the complex plane axes) and plot the point corresponding to an admittance equal to 0.0336S + j·0.0168S. **(1p)**
3. A lossless coupler designed to work on 50Ω terminations has a coupling factor equal to 4.25dB and a directivity equal to 20.7dB. If the input power (50Ω source) is 1.85mW:
   a) Compute the isolated output power (**in dBm and μW**). **(1p)**
   b) Design an ideal ring coupler for the specified coupling factor. **(1p)**
4. A quarter wave transformer is designed to match a 54Ω load to a 50Ω feed line at 6.6GHz.
   a) Design the quarter wave transformer. **(0.5p)**
   b) If at the load in series with the 54Ω resistance we add a 0.37pF capacitor compute the resulting input impedance. **(1.5p)**
5. In order to obtain an 16.05dB gain (minimum) amplifier you must connect in series two devices. You have available the four devices in the following table.

| **Device** | **1** | **2** | **3** | **4** |
|---|---|---|---|---|
| Gain [dB] | 6.1 | 8.5 | 9.4 | 11.7 |
| Noise Factor [dB] | 0.67 | 0.76 | 0.97 | 1.20 |

   a) Specify any two devices you can use to meet the amplifier requirements. **(0.5p)**
   b) Of all the combinations that meet the requirements, which one has the minimum noise factor? Explain your choice. **(1.5p)**
6. The scattering parameters of a transistor at 9.2 GHz are as follows:

| $S_{11}$ | | $S_{12}$ | | $S_{21}$ | | $S_{22}$ | |
|---|---|---|---|---|---|---|---|
| Mag. | Ang. | Mag. | Ang. | Mag. | Ang. | Mag. | Ang. |
| 0.644 | -166.6° | 0.072 | 2.2° | 2.482 | 25.4° | 0.520 | -109.0° |

   a) Prove that the transistor **can be** conjugately matched (50Ω) for maximum gain. (**0.5p**)
   b) Which is the transducer power gain we obtain in this case (in dB)? (**0.5p**)
   b) Compute the input and output reflection coefficients (towards the source and load) needed for conjugate match. **(1p)**
   c) Design the match with single-stub matching sections (any solution). **(1p)**
   d) If for better gain you must add another transistor of the same type, design the matching section between the two amplifier stages (any solution). **(1p)**
   e) In the d) case, which of all solutions for the interstage matching section requires the least substrate area (assume T shape layout)? Explain your choice. **(2p)**

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# *S U B J E C T   N o . 2 2*

**Time allowed: 2 hours; All materials/equipments authorized**

Instructor, sl. Radu Damian      Student: _________________________________  Grupa_______

**Note**. Except where otherwise specified, assume 50Ω reference impedance.
**Note**. Any CAD solution (Matlab, Mathcad, ADS) must be accompanied by the submission of the script/project at the end of the examination.

1. Compute the normalized admittance if the impedance is 44.4Ω − j·56.6Ω and the reference impedance is 85Ω. **(1p)**
2. Outline a Smith Chart (only the external circle and the complex plane axes) and plot the point corresponding to an admittance equal to 0.0184S − j·0.0361S. **(1p)**
3. A lossless coupler designed to work on 50Ω terminations has a coupling factor equal to 4.85dB and a isolation equal to 21.5dB. If the input power (50Ω source) is 4.05mW:
   a) Compute the isolated output power (**in dBm and μW**). **(1p)**
   b) Design an ideal quadrature coupler for the specified coupling factor. **(1p)**
4. A quarter wave transformer is designed to match a 67Ω load to a 50Ω feed line at 7.5GHz.
   a) Design the quarter wave transformer. **(0.5p)**
   b) If at the load in series with the 67Ω resistance we add a 1.05nH inductor compute the resulting input impedance. **(1.5p)**
5. In order to obtain an 14.55dB gain (minimum) amplifier you must connect in series two devices. You have available the four devices in the following table.

| **Device** | **1** | **2** | **3** | **4** |
|---|---|---|---|---|
| Gain [dB] | 5.1 | 8.7 | 9.4 | 11.6 |
| Noise Factor [dB] | 0.51 | 0.80 | 0.94 | 1.21 |

   a) Specify any two devices you can use to meet the amplifier requirements. **(0.5p)**
   b) Of all the combinations that meet the requirements, which one has the minimum noise factor? Explain your choice. **(1.5p)**
6. The scattering parameters of a transistor at 9.5 GHz are as follows:

| $S_{11}$ | | $S_{12}$ | | $S_{21}$ | | $S_{22}$ | |
|---|---|---|---|---|---|---|---|
| Mag. | Ang. | Mag. | Ang. | Mag. | Ang. | Mag. | Ang. |
| 0.635 | -170.5° | 0.075 | 1.0° | 2.443 | 21.5° | 0.520 | -109.0° |

   a) Prove that the transistor **can be** conjugately matched (50Ω) for maximum gain. (**0.5p**)
   b) Which is the transducer power gain we obtain in this case (in dB)? (**0.5p**)
   b) Compute the input and output reflection coefficients (towards the source and load) needed for conjugate match. **(1p)**
   c) Design the match with single-stub matching sections (any solution). **(1p)**
   d) If for better gain you must add another transistor of the same type, design the matching section between the two amplifier stages (any solution). **(1p)**
   e) In the d) case, which of all solutions for the interstage matching section requires the least substrate area (assume T shape layout)? Explain your choice. **(2p)**

# SUBJECT No.23

**Time allowed: 2 hours; All materials/equipments authorized**

Instructor, sl. Radu Damian Student: _________________________________ Grupa_______

**Note**. Except where otherwise specified, assume 50Ω reference impedance.
**Note**. Any CAD solution (Matlab, Mathcad, ADS) must be accompanied by the submission of the script/project at the end of the examination.

1. Compute the normalized admittance if the impedance is 30.7Ω + j·53.0Ω and the reference impedance is 40Ω. **(1p)**
2. Outline a Smith Chart (only the external circle and the complex plane axes) and plot the point corresponding to an admittance equal to 0.0315S − j·0.0161S. **(1p)**
3. A lossless coupler designed to work on 50Ω terminations has a coupling factor equal to 4.00dB and a isolation equal to 24.5dB. If the input power (50Ω source) is 2.80mW:
   a) Compute the isolated output power (**in dBm and μW**). **(1p)**
   b) Design an ideal coupled line coupler for the specified coupling factor. **(1p)**
4. A quarter wave transformer is designed to match a 46Ω load to a 50Ω feed line at 9.3GHz.
   a) Design the quarter wave transformer. **(0.5p)**
   b) If at the load in series with the 46Ω resistance we add a 0.30pF capacitor compute the resulting input impedance. **(1.5p)**
5. In order to obtain an 15.10dB gain (minimum) amplifier you must connect in series two devices. You have available the four devices in the following table.

| **Device** | **1** | **2** | **3** | **4** |
|---|---|---|---|---|
| Gain [dB] | 5.6 | 8.5 | 9.1 | 10.3 |
| Noise Factor [dB] | 0.64 | 0.82 | 0.98 | 1.19 |

   a) Specify any two devices you can use to meet the amplifier requirements. **(0.5p)**
   b) Of all the combinations that meet the requirements, which one has the minimum noise factor? Explain your choice. **(1.5p)**
6. The scattering parameters of a transistor at 13.7 GHz are as follows:

| $S_{11}$ | | $S_{12}$ | | $S_{21}$ | | $S_{22}$ | |
|---|---|---|---|---|---|---|---|
| Mag. | Ang. | Mag. | Ang. | Mag. | Ang. | Mag. | Ang. |
| 0.633 | 135.9° | 0.090 | -33.4° | 1.669 | -31.4° | 0.550 | -156.3° |

   a) Prove that the transistor **<u>can be</u>** conjugately matched (50Ω) for maximum gain. (**0.5p**)
   b) Which is the transducer power gain we obtain in this case (in dB)? (**0.5p**)
   b) Compute the input and output reflection coefficients (towards the source and load) needed for conjugate match. **(1p)**
   c) Design the match with single-stub matching sections (any solution). **(1p)**
   d) If for better gain you must add another transistor of the same type, design the matching section between the two amplifier stages (any solution). **(1p)**
   e) In the d) case, which of all solutions for the interstage matching section requires the least substrate area (assume T shape layout)? Explain your choice. **(2p)**

# S U B J E C T   N o . 2 4

**Time allowed: 2 hours; All materials/equipments authorized**

Instructor, sl. Radu Damian Student: _________________________________ Grupa_______

**Note**. Except where otherwise specified, assume 50Ω reference impedance.
**Note**. Any CAD solution (Matlab, Mathcad, ADS) must be accompanied by the submission of the script/project at the end of the examination.

1. Compute the normalized admittance if the impedance is 49.9Ω + j·60.2Ω and the reference impedance is 50Ω. **(1p)**
2. Outline a Smith Chart (only the external circle and the complex plane axes) and plot the point corresponding to an admittance equal to 0.0327S − j·0.0257S. **(1p)**
3. A lossless coupler designed to work on 50Ω terminations has a coupling factor equal to 4.00dB and a isolation equal to 21.0dB. If the input power (50Ω source) is 2.70mW:
   a) Compute the isolated output power (**in dBm and µW**). **(1p)**
   b) Design an ideal coupled line coupler for the specified coupling factor. **(1p)**
4. A quarter wave transformer is designed to match a 70Ω load to a 50Ω feed line at 7.7GHz.
   a) Design the quarter wave transformer. **(0.5p)**
   b) If at the load in parallel with the 70Ω resistance we add a 1.39nH inductor compute the resulting input impedance. **(1.5p)**
5. In order to obtain an 15.60dB gain (minimum) amplifier you must connect in series two devices. You have available the four devices in the following table.

| **Device** | **1** | **2** | **3** | **4** |
|---|---|---|---|---|
| Gain [dB] | 6.0 | 8.6 | 8.5 | 11.3 |
| Noise Factor [dB] | 0.54 | 0.72 | 0.94 | 1.15 |

   a) Specify any two devices you can use to meet the amplifier requirements. **(0.5p)**
   b) Of all the combinations that meet the requirements, which one has the minimum noise factor? Explain your choice. **(1.5p)**
6. The scattering parameters of a transistor at 15.0 GHz are as follows:

| $S_{11}$ | | $S_{12}$ | | $S_{21}$ | | $S_{22}$ | |
|---|---|---|---|---|---|---|---|
| Mag. | Ang. | Mag. | Ang. | Mag. | Ang. | Mag. | Ang. |
| 0.600 | 120.0° | 0.100 | -42.0° | 1.614 | -48.0° | 0.560 | -168.0° |

   a) Prove that the transistor **can be** conjugately matched (50Ω) for maximum gain. (**0.5p**)
   b) Which is the transducer power gain we obtain in this case (in dB)? (**0.5p**)
   b) Compute the input and output reflection coefficients (towards the source and load) needed for conjugate match. **(1p)**
   c) Design the match with single-stub matching sections (any solution). **(1p)**
   d) If for better gain you must add another transistor of the same type, design the matching section between the two amplifier stages (any solution). **(1p)**
   e) In the d) case, which of all solutions for the interstage matching section requires the least substrate area (assume T shape layout)? Explain your choice. **(2p)**

# *SUBJECT No.25*

**Time allowed: 2 hours; All materials/equipments authorized**

Instructor, sl. Radu Damian Student: _________________________________ Grupa_______

**Note**. Except where otherwise specified, assume 50Ω reference impedance.
**Note**. Any CAD solution (Matlab, Mathcad, ADS) must be accompanied by the submission of the script/project at the end of the examination.

1. Compute the normalized admittance if the impedance is 35.4Ω + j·58.9Ω and the reference impedance is 30Ω. **(1p)**
2. Outline a Smith Chart (only the external circle and the complex plane axes) and plot the point corresponding to an admittance equal to 0.0342S + j·0.0358S. **(1p)**
3. A lossless coupler designed to work on 50Ω terminations has a coupling factor equal to 6.20dB and a isolation equal to 22.9dB. If the input power (50Ω source) is 1.75mW:
   a) Compute the isolated output power (**in dBm and μW**). **(1p)**
   b) Design an ideal quadrature coupler for the specified coupling factor. **(1p)**
4. A quarter wave transformer is designed to match a 28Ω load to a 50Ω feed line at 7.5GHz.
   a) Design the quarter wave transformer. **(0.5p)**
   b) If at the load in series with the 28Ω resistance we add a 1.44nH inductor compute the resulting input impedance. **(1.5p)**
5. In order to obtain an 14.65dB gain (minimum) amplifier you must connect in series two devices. You have available the four devices in the following table.

| **Device** | **1** | **2** | **3** | **4** |
|---|---|---|---|---|
| Gain [dB] | 5.1 | 8.2 | 8.6 | 11.9 |
| Noise Factor [dB] | 0.64 | 0.81 | 0.98 | 1.25 |

   a) Specify any two devices you can use to meet the amplifier requirements. **(0.5p)**
   b) Of all the combinations that meet the requirements, which one has the minimum noise factor? Explain your choice. **(1.5p)**
6. The scattering parameters of a transistor at 9.9 GHz are as follows:

| $S_{11}$ | | $S_{12}$ | | $S_{21}$ | | $S_{22}$ | |
|---|---|---|---|---|---|---|---|
| Mag. | Ang. | Mag. | Ang. | Mag. | Ang. | Mag. | Ang. |
| 0.623 | -175.7° | 0.079 | -0.6° | 2.391 | 16.3° | 0.520 | -109.0° |

   a) Prove that the transistor **can be** conjugately matched (50Ω) for maximum gain. (**0.5p**)
   b) Which is the transducer power gain we obtain in this case (in dB)? (**0.5p**)
   b) Compute the input and output reflection coefficients (towards the source and load) needed for conjugate match. **(1p)**
   c) Design the match with single-stub matching sections (any solution). **(1p)**
   d) If for better gain you must add another transistor of the same type, design the matching section between the two amplifier stages (any solution). **(1p)**
   e) In the d) case, which of all solutions for the interstage matching section requires the least substrate area (assume T shape layout)? Explain your choice. **(2p)**

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# SUBJECT No.26

**Time allowed: 2 hours; All materials/equipments authorized**

Instructor, sl. Radu Damian Student: _________________________________ Grupa_______

**Note**. Except where otherwise specified, assume 50Ω reference impedance.
**Note**. Any CAD solution (Matlab, Mathcad, ADS) must be accompanied by the submission of the script/project at the end of the examination.

1. Compute the normalized admittance if the impedance is 33.8Ω − j·69.6Ω and the reference impedance is 85Ω. **(1p)**
2. Outline a Smith Chart (only the external circle and the complex plane axes) and plot the point corresponding to an admittance equal to 0.0352S − j·0.0178S. **(1p)**
3. A lossless coupler designed to work on 50Ω terminations has a coupling factor equal to 6.65dB and a isolation equal to 20.7dB. If the input power (50Ω source) is 3.80mW:
   a) Compute the isolated output power (**in dBm and μW**). **(1p)**
   b) Design an ideal ring coupler for the specified coupling factor. **(1p)**
4. A quarter wave transformer is designed to match a 27Ω load to a 50Ω feed line at 9.3GHz.
   a) Design the quarter wave transformer. **(0.5p)**
   b) If at the load in parallel with the 27Ω resistance we add a 0.43pF capacitor compute the resulting input impedance. **(1.5p)**
5. In order to obtain an 15.95dB gain (minimum) amplifier you must connect in series two devices. You have available the four devices in the following table.

| **Device** | **1** | **2** | **3** | **4** |
|---|---|---|---|---|
| Gain [dB] | 6.7 | 8.1 | 8.9 | 11.6 |
| Noise Factor [dB] | 0.62 | 0.83 | 1.03 | 1.23 |

   a) Specify any two devices you can use to meet the amplifier requirements. **(0.5p)**
   b) Of all the combinations that meet the requirements, which one has the minimum noise factor? Explain your choice. **(1.5p)**
6. The scattering parameters of a transistor at 10.2 GHz are as follows:

| $S_{11}$ | | $S_{12}$ | | $S_{21}$ | | $S_{22}$ | |
|---|---|---|---|---|---|---|---|
| Mag. | Ang. | Mag. | Ang. | Mag. | Ang. | Mag. | Ang. |
| 0.614 | 180.0° | 0.080 | -2.0° | 2.354 | 12.4° | 0.520 | -110.8° |

   a) Prove that the transistor **can be** conjugately matched (50Ω) for maximum gain. (**0.5p**)
   b) Which is the transducer power gain we obtain in this case (in dB)? (**0.5p**)
   b) Compute the input and output reflection coefficients (towards the source and load) needed for conjugate match. **(1p)**
   c) Design the match with single-stub matching sections (any solution). **(1p)**
   d) If for better gain you must add another transistor of the same type, design the matching section between the two amplifier stages (any solution). **(1p)**
   e) In the d) case, which of all solutions for the interstage matching section requires the least substrate area (assume T shape layout)? Explain your choice. **(2p)**

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# SUBJECT No.27

**Time allowed: 2 hours; All materials/equipments authorized**

Instructor, sl. Radu Damian Student: _________________________________ Grupa_______

**Note**. Except where otherwise specified, assume 50Ω reference impedance.
**Note**. Any CAD solution (Matlab, Mathcad, ADS) must be accompanied by the submission of the script/project at the end of the examination.

1. Compute the normalized admittance if the impedance is 31.4Ω + j·55.9Ω and the reference impedance is 70Ω. **(1p)**
2. Outline a Smith Chart (only the external circle and the complex plane axes) and plot the point corresponding to an admittance equal to 0.0289S + j·0.0158S. **(1p)**
3. A lossless coupler designed to work on 50Ω terminations has a coupling factor equal to 5.75dB and a directivity equal to 20.1dB. If the input power (50Ω source) is 4.00mW:
   a) Compute the isolated output power (**in dBm and μW**). **(1p)**
   b) Design an ideal ring coupler for the specified coupling factor. **(1p)**
4. A quarter wave transformer is designed to match a 57Ω load to a 50Ω feed line at 6.6GHz.
   a) Design the quarter wave transformer. **(0.5p)**
   b) If at the load in parallel with the 57Ω resistance we add a 0.79pF capacitor compute the resulting input impedance. **(1.5p)**
5. In order to obtain an 15.15dB gain (minimum) amplifier you must connect in series two devices. You have available the four devices in the following table.

| **Device** | **1** | **2** | **3** | **4** |
|---|---|---|---|---|
| Gain [dB] | 5.2 | 7.1 | 8.8 | 11.6 |
| Noise Factor [dB] | 0.53 | 0.88 | 1.00 | 1.27 |

   a) Specify any two devices you can use to meet the amplifier requirements. **(0.5p)**
   b) Of all the combinations that meet the requirements, which one has the minimum noise factor? Explain your choice. **(1.5p)**
6. The scattering parameters of a transistor at 9.6 GHz are as follows:

| $S_{11}$ | | $S_{12}$ | | $S_{21}$ | | $S_{22}$ | |
|---|---|---|---|---|---|---|---|
| Mag. | Ang. | Mag. | Ang. | Mag. | Ang. | Mag. | Ang. |
| 0.632 | -171.8° | 0.076 | 0.6° | 2.430 | 20.2° | 0.520 | -109.0° |

   a) Prove that the transistor **can be** conjugately matched (50Ω) for maximum gain. (**0.5p**)
   b) Which is the transducer power gain we obtain in this case (in dB)? (**0.5p**)
   b) Compute the input and output reflection coefficients (towards the source and load) needed for conjugate match. **(1p)**
   c) Design the match with single-stub matching sections (any solution). **(1p)**
   d) If for better gain you must add another transistor of the same type, design the matching section between the two amplifier stages (any solution). **(1p)**
   e) In the d) case, which of all solutions for the interstage matching section requires the least substrate area (assume T shape layout)? Explain your choice. **(2p)**

# S U B J E C T N o . 2 8

**Time allowed: 2 hours; All materials/equipments authorized**

Instructor, sl. Radu Damian Student: _________________________________ Grupa_______

**Note**. Except where otherwise specified, assume 50Ω reference impedance.
**Note**. Any CAD solution (Matlab, Mathcad, ADS) must be accompanied by the submission of the script/project at the end of the examination.

1. Compute the normalized admittance if the impedance is 31.9Ω − j·49.7Ω and the reference impedance is 70Ω. **(1p)**
2. Outline a Smith Chart (only the external circle and the complex plane axes) and plot the point corresponding to an admittance equal to 0.0260S + j·0.0291S. **(1p)**
3. A lossless coupler designed to work on 50Ω terminations has a coupling factor equal to 4.35dB and a directivity equal to 23.6dB. If the input power (50Ω source) is 3.25mW:
   a) Compute the isolated output power (**<u>in dBm and µW</u>**). **(1p)**
   b) Design an ideal ring coupler for the specified coupling factor. **(1p)**
4. A quarter wave transformer is designed to match a 51Ω load to a 50Ω feed line at 7.4GHz.
   a) Design the quarter wave transformer. **(0.5p)**
   b) If at the load in parallel with the 51Ω resistance we add a 1.11nH inductor compute the resulting input impedance. **(1.5p)**
5. In order to obtain an 14.50dB gain (minimum) amplifier you must connect in series two devices. You have available the four devices in the following table.

| **Device** | **1** | **2** | **3** | **4** |
|---|---|---|---|---|
| Gain [dB] | 5.8 | 7.7 | 8.6 | 10.3 |
| Noise Factor [dB] | 0.66 | 0.87 | 1.05 | 1.23 |

   a) Specify any two devices you can use to meet the amplifier requirements. **(0.5p)**
   b) Of all the combinations that meet the requirements, which one has the minimum noise factor? Explain your choice. **(1.5p)**

6. The scattering parameters of a transistor at 13.8 GHz are as follows:

| $S_{11}$ | | $S_{12}$ | | $S_{21}$ | | $S_{22}$ | |
|---|---|---|---|---|---|---|---|
| Mag. | Ang. | Mag. | Ang. | Mag. | Ang. | Mag. | Ang. |
| 0.632 | 134.6° | 0.090 | -33.6° | 1.663 | -32.6° | 0.550 | -157.2° |

   a) Prove that the transistor **<u>can be</u>** conjugately matched (50Ω) for maximum gain. (**0.5p**)
   b) Which is the transducer power gain we obtain in this case (in dB)? (**0.5p**)
   b) Compute the input and output reflection coefficients (towards the source and load) needed for conjugate match. **(1p)**
   c) Design the match with single-stub matching sections (any solution). **(1p)**
   d) If for better gain you must add another transistor of the same type, design the matching section between the two amplifier stages (any solution). **(1p)**
   e) In the d) case, which of all solutions for the interstage matching section requires the least substrate area (assume T shape layout)? Explain your choice. **(2p)**

# SUBJECT No.29

**Time allowed: 2 hours; All materials/equipments authorized**

Instructor, sl. Radu Damian Student: _________________________________ Grupa_______

**Note**. Except where otherwise specified, assume 50Ω reference impedance.
**Note**. Any CAD solution (Matlab, Mathcad, ADS) must be accompanied by the submission of the script/project at the end of the examination.

1. Compute the normalized admittance if the impedance is 49.2Ω − j·38.3Ω and the reference impedance is 60Ω. **(1p)**
2. Outline a Smith Chart (only the external circle and the complex plane axes) and plot the point corresponding to an admittance equal to 0.0305S + j·0.0172S. **(1p)**
3. A lossless coupler designed to work on 50Ω terminations has a coupling factor equal to 5.75dB and a directivity equal to 22.1dB. If the input power (50Ω source) is 1.15mW:
   a) Compute the isolated output power (**in dBm and µW**). **(1p)**
   b) Design an ideal ring coupler for the specified coupling factor. **(1p)**
4. A quarter wave transformer is designed to match a 53Ω load to a 50Ω feed line at 8.0GHz.
   a) Design the quarter wave transformer. **(0.5p)**
   b) If at the load in parallel with the 53Ω resistance we add a 0.40pF capacitor compute the resulting input impedance. **(1.5p)**
5. In order to obtain an 14.45dB gain (minimum) amplifier you must connect in series two devices. You have available the four devices in the following table.

| **Device** | **1** | **2** | **3** | **4** |
|---|---|---|---|---|
| Gain [dB] | 5.2 | 8.2 | 8.3 | 11.2 |
| Noise Factor [dB] | 0.57 | 0.73 | 1.08 | 1.15 |

   a) Specify any two devices you can use to meet the amplifier requirements. **(0.5p)**
   b) Of all the combinations that meet the requirements, which one has the minimum noise factor? Explain your choice. **(1.5p)**
6. The scattering parameters of a transistor at 13.0 GHz are as follows:

| $S_{11}$ | | $S_{12}$ | | $S_{21}$ | | $S_{22}$ | |
|---|---|---|---|---|---|---|---|
| Mag. | Ang. | Mag. | Ang. | Mag. | Ang. | Mag. | Ang. |
| 0.640 | 145.0° | 0.090 | -32.0° | 1.709 | -23.0° | 0.550 | -150.0° |

   a) Prove that the transistor **can be** conjugately matched (50Ω) for maximum gain. (**0.5p**)
   b) Which is the transducer power gain we obtain in this case (in dB)? (**0.5p**)
   b) Compute the input and output reflection coefficients (towards the source and load) needed for conjugate match. **(1p)**
   c) Design the match with single-stub matching sections (any solution). **(1p)**
   d) If for better gain you must add another transistor of the same type, design the matching section between the two amplifier stages (any solution). **(1p)**
   e) In the d) case, which of all solutions for the interstage matching section requires the least substrate area (assume T shape layout)? Explain your choice. **(2p)**

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# SUBJECT No.30

**Time allowed: 2 hours; All materials/equipments authorized**

Instructor, sl. Radu Damian Student: _________________________________ Grupa_______

**Note**. Except where otherwise specified, assume 50Ω reference impedance.
**Note**. Any CAD solution (Matlab, Mathcad, ADS) must be accompanied by the submission of the script/project at the end of the examination.

1. Compute the normalized admittance if the impedance is 35.7Ω + j·66.3Ω and the reference impedance is 85Ω. **(1p)**
2. Outline a Smith Chart (only the external circle and the complex plane axes) and plot the point corresponding to an admittance equal to 0.0133S − j·0.0223S. **(1p)**
3. A lossless coupler designed to work on 50Ω terminations has a coupling factor equal to 4.20dB and a isolation equal to 21.5dB. If the input power (50Ω source) is 1.80mW:
   a) Compute the isolated output power (**in dBm and µW**). **(1p)**
   b) Design an ideal coupled line coupler for the specified coupling factor. **(1p)**
4. A quarter wave transformer is designed to match a 46Ω load to a 50Ω feed line at 7.3GHz.
   a) Design the quarter wave transformer. **(0.5p)**
   b) If at the load in series with the 46Ω resistance we add a 0.32pF capacitor compute the resulting input impedance. **(1.5p)**
5. In order to obtain an 15.80dB gain (minimum) amplifier you must connect in series two devices. You have available the four devices in the following table.

| **Device** | **1** | **2** | **3** | **4** |
|---|---|---|---|---|
| Gain [dB] | 5.5 | 7.5 | 9.8 | 11.9 |
| Noise Factor [dB] | 0.64 | 0.84 | 0.95 | 1.25 |

   a) Specify any two devices you can use to meet the amplifier requirements. **(0.5p)**
   b) Of all the combinations that meet the requirements, which one has the minimum noise factor? Explain your choice. **(1.5p)**
6. The scattering parameters of a transistor at 9.8 GHz are as follows:

| $S_{11}$ | | $S_{12}$ | | $S_{21}$ | | $S_{22}$ | |
|---|---|---|---|---|---|---|---|
| Mag. | Ang. | Mag. | Ang. | Mag. | Ang. | Mag. | Ang. |
| 0.626 | -174.4° | 0.078 | -0.2° | 2.404 | 17.6° | 0.520 | -109.0° |

   a) Prove that the transistor **can be** conjugately matched (50Ω) for maximum gain. (**0.5p**)
   b) Which is the transducer power gain we obtain in this case (in dB)? (**0.5p**)
   b) Compute the input and output reflection coefficients (towards the source and load) needed for conjugate match. **(1p)**
   c) Design the match with single-stub matching sections (any solution). **(1p)**
   d) If for better gain you must add another transistor of the same type, design the matching section between the two amplifier stages (any solution). **(1p)**
   e) In the d) case, which of all solutions for the interstage matching section requires the least substrate area (assume T shape layout)? Explain your choice. **(2p)**

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# *SUBJECT No.31*

**Time allowed: 2 hours; All materials/equipments authorized**

Instructor, sl. Radu Damian Student: _________________________________ Grupa_______

**Note**. Except where otherwise specified, assume 50Ω reference impedance.
**Note**. Any CAD solution (Matlab, Mathcad, ADS) must be accompanied by the submission of the script/project at the end of the examination.

1. Compute the normalized admittance if the impedance is 51.9Ω + j·67.1Ω and the reference impedance is 100Ω. **(1p)**
2. Outline a Smith Chart (only the external circle and the complex plane axes) and plot the point corresponding to an admittance equal to 0.0114S − j·0.0232S. **(1p)**
3. A lossless coupler designed to work on 50Ω terminations has a coupling factor equal to 6.30dB and a directivity equal to 24.4dB. If the input power (50Ω source) is 3.40mW:
   a) Compute the isolated output power (**in dBm and μW**). **(1p)**
   b) Design an ideal quadrature coupler for the specified coupling factor. **(1p)**
4. A quarter wave transformer is designed to match a 41Ω load to a 50Ω feed line at 9.5GHz.
   a) Design the quarter wave transformer. **(0.5p)**
   b) If at the load in series with the 41Ω resistance we add a 0.74nH inductor compute the resulting input impedance. **(1.5p)**
5. In order to obtain an 16.70dB gain (minimum) amplifier you must connect in series two devices. You have available the four devices in the following table.

| **Device** | **1** | **2** | **3** | **4** |
|---|---|---|---|---|
| Gain [dB] | 6.8 | 7.4 | 9.8 | 11.8 |
| Noise Factor [dB] | 0.63 | 0.88 | 0.99 | 1.26 |

   a) Specify any two devices you can use to meet the amplifier requirements. **(0.5p)**
   b) Of all the combinations that meet the requirements, which one has the minimum noise factor? Explain your choice. **(1.5p)**
6. The scattering parameters of a transistor at 12.6 GHz are as follows:

| $S_{11}$ | | $S_{12}$ | | $S_{21}$ | | $S_{22}$ | |
|---|---|---|---|---|---|---|---|
| Mag. | Ang. | Mag. | Ang. | Mag. | Ang. | Mag. | Ang. |
| 0.640 | 150.2° | 0.090 | -30.0° | 1.732 | -17.8° | 0.550 | -146.0° |

   a) Prove that the transistor **can be** conjugately matched (50Ω) for maximum gain. (**0.5p**)
   b) Which is the transducer power gain we obtain in this case (in dB)? (**0.5p**)
   b) Compute the input and output reflection coefficients (towards the source and load) needed for conjugate match. **(1p)**
   c) Design the match with single-stub matching sections (any solution). **(1p)**
   d) If for better gain you must add another transistor of the same type, design the matching section between the two amplifier stages (any solution). **(1p)**
   e) In the d) case, which of all solutions for the interstage matching section requires the least substrate area (assume T shape layout)? Explain your choice. **(2p)**

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# SUBJECT No.32

**Time allowed: 2 hours; All materials/equipments authorized**

Instructor, sl. Radu Damian Student: ________________________________ Grupa_______

**Note**. Except where otherwise specified, assume 50Ω reference impedance.
**Note**. Any CAD solution (Matlab, Mathcad, ADS) must be accompanied by the submission of the script/project at the end of the examination.

1. Compute the normalized admittance if the impedance is 62.2Ω − j·58.7Ω and the reference impedance is 60Ω. **(1p)**
2. Outline a Smith Chart (only the external circle and the complex plane axes) and plot the point corresponding to an admittance equal to 0.0299S + j·0.0282S. **(1p)**
3. A lossless coupler designed to work on 50Ω terminations has a coupling factor equal to 6.50dB and a directivity equal to 22.5dB. If the input power (50Ω source) is 1.95mW:
   a) Compute the isolated output power (**in dBm and μW**). **(1p)**
   b) Design an ideal coupled line coupler for the specified coupling factor. **(1p)**
4. A quarter wave transformer is designed to match a 53Ω load to a 50Ω feed line at 7.1GHz.
   a) Design the quarter wave transformer. **(0.5p)**
   b) If at the load in parallel with the 53Ω resistance we add a 0.35pF capacitor compute the resulting input impedance. **(1.5p)**
5. In order to obtain an 15.10dB gain (minimum) amplifier you must connect in series two devices. You have available the four devices in the following table.

| Device | 1 | 2 | 3 | 4 |
|---|---|---|---|---|
| Gain [dB] | 6.2 | 7.6 | 8.2 | 11.5 |
| Noise Factor [dB] | 0.52 | 0.89 | 0.98 | 1.21 |

   a) Specify any two devices you can use to meet the amplifier requirements. **(0.5p)**
   b) Of all the combinations that meet the requirements, which one has the minimum noise factor? Explain your choice. **(1.5p)**
6. The scattering parameters of a transistor at 13.2 GHz are as follows:

| $S_{11}$ | | $S_{12}$ | | $S_{21}$ | | $S_{22}$ | |
|---|---|---|---|---|---|---|---|
| Mag. | Ang. | Mag. | Ang. | Mag. | Ang. | Mag. | Ang. |
| 0.638 | 142.4° | 0.090 | -32.4° | 1.698 | -25.4° | 0.550 | -151.8° |

   a) Prove that the transistor **can be** conjugately matched (50Ω) for maximum gain. (**0.5p**)
   b) Which is the transducer power gain we obtain in this case (in dB)? (**0.5p**)
   b) Compute the input and output reflection coefficients (towards the source and load) needed for conjugate match. **(1p)**
   c) Design the match with single-stub matching sections (any solution). **(1p)**
   d) If for better gain you must add another transistor of the same type, design the matching section between the two amplifier stages (any solution). **(1p)**
   e) In the d) case, which of all solutions for the interstage matching section requires the least substrate area (assume T shape layout)? Explain your choice. **(2p)**

# S U B J E C T N o . 3 3

**Time allowed: 2 hours; All materials/equipments authorized**

Instructor, sl. Radu Damian Student: _________________________________ Grupa_______

**Note**. Except where otherwise specified, assume 50Ω reference impedance.

**Note**. Any CAD solution (Matlab, Mathcad, ADS) must be accompanied by the submission of the script/project at the end of the examination.

1. Compute the normalized admittance if the impedance is 34.3Ω − j·38.7Ω and the reference impedance is 70Ω. **(1p)**
2. Outline a Smith Chart (only the external circle and the complex plane axes) and plot the point corresponding to an admittance equal to 0.0388S + j·0.0238S. **(1p)**
3. A lossless coupler designed to work on 50Ω terminations has a coupling factor equal to 4.35dB and a isolation equal to 24.6dB. If the input power (50Ω source) is 3.05mW:
   a) Compute the isolated output power (**in dBm and μW**). **(1p)**
   b) Design an ideal coupled line coupler for the specified coupling factor. **(1p)**
4. A quarter wave transformer is designed to match a 31Ω load to a 50Ω feed line at 9.0GHz.
   a) Design the quarter wave transformer. **(0.5p)**
   b) If at the load in parallel with the 31Ω resistance we add a 0.62nH inductor compute the resulting input impedance. **(1.5p)**
5. In order to obtain an 16.70dB gain (minimum) amplifier you must connect in series two devices. You have available the four devices in the following table.

| **Device** | **1** | **2** | **3** | **4** |
|---|---|---|---|---|
| Gain [dB] | 6.0 | 8.1 | 9.9 | 11.1 |
| Noise Factor [dB] | 0.53 | 0.77 | 0.92 | 1.27 |

   a) Specify any two devices you can use to meet the amplifier requirements. **(0.5p)**
   b) Of all the combinations that meet the requirements, which one has the minimum noise factor? Explain your choice. **(1.5p)**

6. The scattering parameters of a transistor at 9.4 GHz are as follows:

| $S_{11}$ | | $S_{12}$ | | $S_{21}$ | | $S_{22}$ | |
|---|---|---|---|---|---|---|---|
| Mag. | Ang. | Mag. | Ang. | Mag. | Ang. | Mag. | Ang. |
| 0.638 | -169.2° | 0.074 | 1.4° | 2.456 | 22.8° | 0.520 | -109.0° |

   a) Prove that the transistor **can be** conjugately matched (50Ω) for maximum gain. (**0.5p**)
   b) Which is the transducer power gain we obtain in this case (in dB)? (**0.5p**)
   b) Compute the input and output reflection coefficients (towards the source and load) needed for conjugate match. **(1p)**
   c) Design the match with single-stub matching sections (any solution). **(1p)**
   d) If for better gain you must add another transistor of the same type, design the matching section between the two amplifier stages (any solution). **(1p)**
   e) In the d) case, which of all solutions for the interstage matching section requires the least substrate area (assume T shape layout)? Explain your choice. **(2p)**

# S U B J E C T N o . 3 4

**Time allowed: 2 hours; All materials/equipments authorized**

Instructor, sl. Radu Damian Student: __________________________________ Grupa_______

**Note**. Except where otherwise specified, assume 50Ω reference impedance.
**Note**. Any CAD solution (Matlab, Mathcad, ADS) must be accompanied by the submission of the script/project at the end of the examination.

1. Compute the normalized admittance if the impedance is 33.0Ω − j·54.7Ω and the reference impedance is 80Ω. **(1p)**
2. Outline a Smith Chart (only the external circle and the complex plane axes) and plot the point corresponding to an admittance equal to 0.0206S − j·0.0147S. **(1p)**
3. A lossless coupler designed to work on 50Ω terminations has a coupling factor equal to 6.80dB and a directivity equal to 23.5dB. If the input power (50Ω source) is 1.55mW:
   a) Compute the isolated output power (**in dBm and μW**). **(1p)**
   b) Design an ideal quadrature coupler for the specified coupling factor. **(1p)**
4. A quarter wave transformer is designed to match a 58Ω load to a 50Ω feed line at 7.6GHz.
   a) Design the quarter wave transformer. **(0.5p)**
   b) If at the load in series with the 58Ω resistance we add a 0.33pF capacitor compute the resulting input impedance. **(1.5p)**
5. In order to obtain an 16.65dB gain (minimum) amplifier you must connect in series two devices. You have available the four devices in the following table.

| **Device** | **1** | **2** | **3** | **4** |
|---|---|---|---|---|
| Gain [dB] | 6.7 | 8.4 | 9.8 | 10.2 |
| Noise Factor [dB] | 0.69 | 0.77 | 1.07 | 1.29 |

   a) Specify any two devices you can use to meet the amplifier requirements. **(0.5p)**
   b) Of all the combinations that meet the requirements, which one has the minimum noise factor? Explain your choice. **(1.5p)**

6. The scattering parameters of a transistor at 9.0 GHz are as follows:

| $S_{11}$ | | $S_{12}$ | | $S_{21}$ | | $S_{22}$ | |
|---|---|---|---|---|---|---|---|
| Mag. | Ang. | Mag. | Ang. | Mag. | Ang. | Mag. | Ang. |
| 0.650 | -164.0° | 0.070 | 3.0° | 2.508 | 28.0° | 0.520 | -109.0° |

   a) Prove that the transistor **can be** conjugately matched (50Ω) for maximum gain. (**0.5p**)
   b) Which is the transducer power gain we obtain in this case (in dB)? (**0.5p**)
   b) Compute the input and output reflection coefficients (towards the source and load) needed for conjugate match. **(1p)**
   c) Design the match with single-stub matching sections (any solution). **(1p)**
   d) If for better gain you must add another transistor of the same type, design the matching section between the two amplifier stages (any solution). **(1p)**
   e) In the d) case, which of all solutions for the interstage matching section requires the least substrate area (assume T shape layout)? Explain your choice. **(2p)**

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# SUBJECT No.35

**Time allowed: 2 hours; All materials/equipments authorized**

Instructor, sl. Radu Damian Student: _________________________________ Grupa_______

**Note**. Except where otherwise specified, assume 50Ω reference impedance.
**Note**. Any CAD solution (Matlab, Mathcad, ADS) must be accompanied by the submission of the script/project at the end of the examination.

1. Compute the normalized admittance if the impedance is 55.9Ω + j·61.3Ω and the reference impedance is 100Ω. **(1p)**
2. Outline a Smith Chart (only the external circle and the complex plane axes) and plot the point corresponding to an admittance equal to 0.0275S − j·0.0313S. **(1p)**
3. A lossless coupler designed to work on 50Ω terminations has a coupling factor equal to 4.65dB and a isolation equal to 20.2dB. If the input power (50Ω source) is 2.50mW:
   a) Compute the isolated output power (**in dBm and μW**). **(1p)**
   b) Design an ideal quadrature coupler for the specified coupling factor. **(1p)**
4. A quarter wave transformer is designed to match a 45Ω load to a 50Ω feed line at 7.6GHz.
   a) Design the quarter wave transformer. **(0.5p)**
   b) If at the load in parallel with the 45Ω resistance we add a 0.73nH inductor compute the resulting input impedance. **(1.5p)**
5. In order to obtain an 15.40dB gain (minimum) amplifier you must connect in series two devices. You have available the four devices in the following table.

| **Device** | **1** | **2** | **3** | **4** |
|---|---|---|---|---|
| Gain [dB] | 6.8 | 7.6 | 8.2 | 10.5 |
| Noise Factor [dB] | 0.56 | 0.81 | 0.93 | 1.22 |

   a) Specify any two devices you can use to meet the amplifier requirements. **(0.5p)**
   b) Of all the combinations that meet the requirements, which one has the minimum noise factor? Explain your choice. **(1.5p)**

6. The scattering parameters of a transistor at 9.3 GHz are as follows:

| $S_{11}$ | | $S_{12}$ | | $S_{21}$ | | $S_{22}$ | |
|---|---|---|---|---|---|---|---|
| Mag. | Ang. | Mag. | Ang. | Mag. | Ang. | Mag. | Ang. |
| 0.641 | -167.9° | 0.073 | 1.8° | 2.469 | 24.1° | 0.520 | -109.0° |

   a) Prove that the transistor **can be** conjugately matched (50Ω) for maximum gain. (**0.5p**)
   b) Which is the transducer power gain we obtain in this case (in dB)? (**0.5p**)
   b) Compute the input and output reflection coefficients (towards the source and load) needed for conjugate match. **(1p)**
   c) Design the match with single-stub matching sections (any solution). **(1p)**
   d) If for better gain you must add another transistor of the same type, design the matching section between the two amplifier stages (any solution). **(1p)**
   e) In the d) case, which of all solutions for the interstage matching section requires the least substrate area (assume T shape layout)? Explain your choice. **(2p)**