Subject no. 1

1. $Z = 14.52 + j\cdot(-27.08)$; $\Gamma = (Z - Z_0)/(Z + Z_0) = -0.318 + j\cdot(-0.553) = 0.638\angle -119.9°$, plot point in complex plane either with rectangular coordinates or polar coordinates

2. $y = 1.225 - j\cdot 0.995$; $Z = Z_0 / (1.225 - j\cdot 0.995) = 24.592\Omega + j\cdot(19.9747)\Omega$

3. a) Pin = 3.90mW = 5.911dBm; Pc = 5.911dBm - 4.55dB = 1.361 dBm = 1.3679mW
Ideal lossless coupler: P_T = 3.90mW – 1.3679mW = 2.5321 mW= 4.035 dBm ; after amplifier G_1 we have $P_{A1} = P_T + G_1$ = 4.035 dBm + 8.9dB = 12.935 dBm ; inside the filter passband maximum attenuation introduced by the filter is equal to the ripple, $P_{out,max} = P_{A1}$ = 12.935 dBm = 19.66mW, $P_{out,min} = P_{A1} - R$ = 12.935 dBm – 0.5dB = 12.435 dBm = 17.518 mW
b) $P_{meas} = P_C + G_2$ = 1.361 dBm + 9.8dB = 11.161 dBm = 13.064 mW
c) Outside the passband $P_{out} = P_{A1} - A$ = 12.935 dBm – 22.7dB = -9.765 dBm = 0.106 mW

4. $\Gamma = (Z - Z_0)/(Z + Z_0) = 0.107 + j\cdot(0.399) = 0.413\angle 75.046°$;
b) Complex calculus from L7/L8, 2 solutions for the match, $Z_0 = 50\Omega$ lines
$\theta_{S1} = 19.7°$; $Im(y_S) = -0.908$; $\theta_{p1} = 137.8°$ **and** $\theta_{S2} = 85.3°$; $Im(y_S) = 0.908$; $\theta_{p2} = 42.2°$
c) Obviously the shunt stub θ_p is towards the 50 ohm source

5. In any order we cascade the two devices the gain will be the same $G = G_1 + G_2$ = 9.2dB + 11.4dB = 20.6dB. The "best" placement for the two devices refers to the minimum noise factor.
F_1 = 1.28dB=1.343, F_2 = 1.00dB=1.259, G_1 = 9.2dB = 8.318, G_2 = 11.4dB = 13.804
We compute $F_{12} = F_1 + (F_2-1)/G_1 = 1.374$ and $F_{21} = F_2 + (F_1-1)/G_2 = 1.284$, we obtain a lower noise factor when we first use device 2 in the cascade. The result is F = 1.085dB and G = 20.6dB

6. a) The match for maximum gain is available only if the transistor is unconditionally stable.
$|S_{11}| = 0.640 < 1$; $|S_{22}| = 0.550 < 1$; $K = 1.186 > 1$; $|\Delta| = |(0.255) + j\cdot(0.119)| = 0.282 < 1$
b) $B_1 = 1.028$; $C_1 = (-0.387) + j\cdot(0.324)$; $\Gamma_S = (-0.631) + j\cdot(-0.529) = 0.823\angle -140.1°$
$B_2 = 0.814$; $C_2 = (-0.369) + j\cdot(-0.140)$; $\Gamma_L = (-0.730) + j\cdot(0.277) = 0.781\angle 159.3°$
c) towards the source: $\theta_{s1} = 142.7°$; $\theta_{p1} = 109.0°$ **or** $\theta_{s2} = 177.3°$; $\theta_{p2} = 71.0°$
toward the load: $\theta_{s1} = 171.0°$; $\theta_{p1} = 111.8°$ **or** $\theta_{s2} = 29.7°$; $\theta_{p2} = 68.2°$

Subject no. 2

1. $Z = 39.00 + j\cdot(32.80)$; $\Gamma = (Z - Z_0)/(Z + Z_0) = 0.011 + j\cdot(0.365) = 0.365\angle 88.3°$, plot point in complex plane either with rectangular coordinates or polar coordinates

2. $y = 1.145 - j\cdot 0.955$; $Z = Z_0 / (1.145 - j\cdot 0.955) = 25.753\Omega + j\cdot(21.4795)\Omega$

3. a) Pin = 1.45mW = 1.614dBm; Pc = 1.614dBm - 4.05dB = -2.436 dBm = 0.5706mW
Ideal lossless coupler: P_T = 1.45mW – 0.5706mW = 0.8794 mW= -0.558 dBm ; after amplifier G_1 we have $P_{A1} = P_T + G_1$ = -0.558 dBm + 7.9dB = 7.342 dBm ; inside the filter passband maximum attenuation introduced by the filter is equal to the ripple, $P_{out,max} = P_{A1}$ = 7.342 dBm = 5.42mW, $P_{out,min} = P_{A1} - R$ = 7.342 dBm – 0.8dB = 6.542 dBm = 4.510 mW
b) $P_{meas} = P_C + G_2$ = -2.436 dBm + 10.4dB = 7.964 dBm = 6.257 mW
c) Outside the passband $P_{out} = P_{A1} - A$ = 7.342 dBm – 15.3dB = -7.958 dBm = 0.160 mW

4. $\Gamma = (Z - Z_0)/(Z + Z_0) = 0.294 + j\cdot(-0.325) = 0.438\angle -47.927°$;
b) Complex calculus from L7/L8, 2 solutions for the match, $Z_0 = 50\Omega$ lines
$\theta_{S1} = 82.0°$; $Im(y_S) = -0.975$; $\theta_{p1} = 135.7°$ **and** $\theta_{S2} = 146.0°$; $Im(y_S) = 0.975$; $\theta_{p2} = 44.3°$
c) Obviously the shunt stub θ_p is towards the 50 ohm source

5. In any order we cascade the two devices the gain will be the same $G = G_1 + G_2$ = 9.6dB + 11.8dB = 21.4dB. The "best" placement for the two devices refers to the minimum noise factor.
F_1 = 1.25dB=1.334, F_2 = 1.00dB=1.259, G_1 = 9.6dB = 9.120, G_2 = 11.8dB = 15.136
We compute $F_{12} = F_1 + (F_2-1)/G_1 = 1.362$ and $F_{21} = F_2 + (F_1-1)/G_2 = 1.281$, we obtain a lower noise factor when we first use device 2 in the cascade. The result is F = 1.075dB and G = 21.4dB

6. a) The match for maximum gain is available only if the transistor is unconditionally stable.
$|S_{11}| = 0.612 < 1$; $|S_{22}| = 0.556 < 1$; $K = 1.207 > 1$; $|\Delta| = |(0.239) + j\cdot(-0.062)| = 0.247 < 1$
b) $B_1 = 1.004$; $C_1 = (-0.230) + j\cdot(0.433)$; $\Gamma_S = (-0.379) + j\cdot(-0.713) = 0.808\angle -118.0°$
$B_2 = 0.873$; $C_2 = (-0.421) + j\cdot(-0.051)$; $\Gamma_L = (-0.776) + j\cdot(0.094) = 0.781\angle 173.1°$
c) towards the source: $\theta_{s1} = 130.9°$; $\theta_{p1} = 110.1°$ **or** $\theta_{s2} = 167.1°$; $\theta_{p2} = 69.9°$
toward the load: $\theta_{s1} = 164.1°$; $\theta_{p1} = 111.8°$ **or** $\theta_{s2} = 22.8°$; $\theta_{p2} = 68.2°$

Subject no. 3

1. $Z = 60.00 + j\cdot(52.98)$; $\Gamma = (Z - Z_0)/(Z + Z_0) = 0.262 + j\cdot(0.355) = 0.442\angle 53.6°$, plot point in complex plane either with rectangular coordinates or polar coordinates

2. $y = 1.040 - j\cdot 0.825$; $Z = Z_0 / (1.040 - j\cdot 0.825) = 29.508\Omega + j\cdot(23.4079)\Omega$

3. a) Pin = 1.85mW = 2.672dBm; Pc = 2.672dBm - 4.50dB = -1.828 dBm = 0.6564mW
Ideal lossless coupler: P_T = 1.85mW – 0.6564mW = 1.1936 mW= 0.769 dBm ; after amplifier G_1 we have $P_{A1} = P_T + G_1$ = 0.769 dBm + 6.9dB = 7.669 dBm ; inside the filter passband maximum attenuation introduced by the filter is equal to the ripple, $P_{out,max} = P_{A1}$ = 7.669 dBm = 5.85mW, $P_{out,min} = P_{A1} - R$ = 7.669 dBm – 2.5dB = 5.169 dBm = 3.287 mW
b) $P_{meas} = P_C + G_2$ = -1.828 dBm + 9.8dB = 7.972 dBm = 6.269 mW
c) Outside the passband $P_{out} = P_{A1} - A$ = 7.669 dBm – 16.3dB = -8.631 dBm = 0.137 mW

4. $\Gamma = (Z - Z_0)/(Z + Z_0) = 0.251 + j\cdot(-0.323) = 0.409\angle -52.134°$;
b) Complex calculus from L7/L8, 2 solutions for the match, $Z_0 = 50\Omega$ lines
$\theta_{S1} = 83.1°$; $Im(y_S) = -0.896$; $\theta_{p1} = 138.1°$ **and** $\theta_{S2} = 149.0°$; $Im(y_S) = 0.896$; $\theta_{p2} = 41.9°$
c) Obviously the shunt stub θ_p is towards the 50 ohm source

5. In any order we cascade the two devices the gain will be the same $G = G_1 + G_2$ = 9.4dB + 11.6dB = 21.0dB. The "best" placement for the two devices refers to the minimum noise factor.
F_1 = 1.23dB=1.327, F_2 = 0.93dB=1.239, G_1 = 9.4dB = 8.710, G_2 = 11.6dB = 14.454
We compute $F_{12} = F_1 + (F_2-1)/G_1 = 1.355$ and $F_{21} = F_2 + (F_1-1)/G_2 = 1.261$, we obtain a lower noise factor when we first use device 2 in the cascade. The result is F = 1.009dB and G = 21.0dB

6. a) The match for maximum gain is available only if the transistor is unconditionally stable.
$|S_{11}| = 0.615 < 1$; $|S_{22}| = 0.555 < 1$; $K = 1.211 > 1$; $|\Delta| = |(0.243) + j\cdot(-0.055)| = 0.249 < 1$
b) $B_1 = 1.008$; $C_1 = (-0.241) + j\cdot(0.430)$; $\Gamma_S = (-0.395) + j\cdot(-0.705) = 0.808\angle -119.3°$
$B_2 = 0.868$; $C_2 = (-0.417) + j\cdot(-0.057)$; $\Gamma_L = (-0.772) + j\cdot(0.105) = 0.780\angle 172.2°$
c) towards the source: $\theta_{s1} = 131.6°$; $\theta_{p1} = 110.0°$ **or** $\theta_{s2} = 167.7°$; $\theta_{p2} = 70.0°$
toward the load: $\theta_{s1} = 164.5°$; $\theta_{p1} = 111.9°$ **or** $\theta_{s2} = 23.3°$; $\theta_{p2} = 68.1°$

Subject no. 4

1. $Z = 28.56+ j\cdot(13.56)$; $\Gamma = (Z - Z_0)/(Z + Z_0) = -0.236+ j\cdot(0.213) = 0.318\angle 137.9°$, plot point in complex plane either with rectangular coordinates or polar coordinates

2. $y = 0.925 + j\cdot 0.925$; $Z = Z_0 / (0.925 + j\cdot 0.925) = 27.027\Omega + j\cdot(-27.0270)\Omega$

3. a) Pin = 2.65mW = 4.232dBm; Pc = 4.232dBm - 4.95dB = -0.718 dBm = 0.8477mW
Ideal lossless coupler: P_T = 2.65mW – 0.8477mW = 1.8023 mW= 2.558 dBm ; after amplifier G_1 we have $P_{A1} = P_T + G_1$ = 2.558 dBm + 6.9dB = 9.458 dBm ; inside the filter passband maximum attenuation introduced by the filter is equal to the ripple, $P_{out,max} = P_{A1}$ = 9.458 dBm = 8.83mW, $P_{out,min} = P_{A1} - R$ = 9.458 dBm – 2.7dB = 6.758 dBm = 4.741 mW
b) $P_{meas} = P_C + G_2$ = -0.718 dBm + 11.0dB = 10.282 dBm = 10.672 mW
c) Outside the passband $P_{out} = P_{A1} - A$ = 9.458 dBm – 24.1dB = -14.642 dBm = 0.034 mW

4. $\Gamma = (Z - Z_0)/(Z + Z_0) = 0.223 + j\cdot(0.336) = 0.403\angle 56.351°$;
b) Complex calculus from L7/L8, 2 solutions for the match, $Z_0 = 50\Omega$ lines
$\theta_{S1} = 28.7°$; $Im(y_S) = -0.881$; $\theta_{p1} = 138.6°$ **and** $\theta_{S2} = 94.9°$; $Im(y_S) = 0.881$; $\theta_{p2} = 41.4°$
c) Obviously the shunt stub θ_p is towards the 50 ohm source

5. In any order we cascade the two devices the gain will be the same $G = G_1 + G_2$ = 9.5dB + 10.4dB = 19.9dB. The "best" placement for the two devices refers to the minimum noise factor.
F_1 = 1.25dB=1.334, F_2 = 1.05dB=1.274, G_1 = 9.5dB = 8.913, G_2 = 10.4dB = 10.965
We compute $F_{12} = F_1 + (F_2-1)/G_1 = 1.364$ and $F_{21} = F_2 + (F_1-1)/G_2 = 1.304$, we obtain a lower noise factor when we first use device 2 in the cascade. The result is F = 1.153dB and G = 19.9dB

6. a) The match for maximum gain is available only if the transistor is unconditionally stable.
$|S_{11}| = 0.631 < 1$; $|S_{22}| = 0.550 < 1$; $K = 1.227 > 1$; $|\Delta| = |(0.258)+ j\cdot(-0.008)| = 0.258 < 1$
b) $B_1 = 1.029$; $C_1 = (-0.303) + j\cdot(0.402)$; $\Gamma_S = (-0.488) + j\cdot(-0.649) = 0.811\angle -126.9°$
$B_2 = 0.838$; $C_2 = (-0.395) + j\cdot(-0.090)$; $\Gamma_L = (-0.753) + j\cdot(0.171) = 0.772\angle 167.2°$
c) towards the source: $\theta_{s1} = 135.6°$; $\theta_{p1} = 109.8°$ **or** $\theta_{s2} = 171.4°$; $\theta_{p2} = 70.2°$
toward the load: $\theta_{s1} = 166.7°$; $\theta_{p1} = 112.4°$ **or** $\theta_{s2} = 26.1°$; $\theta_{p2} = 67.6°$

Subject no. 5

1. $Z = 16.55 + j\cdot(-30.56)$; $\Gamma = (Z - Z_0)/(Z + Z_0) = -0.241 + j\cdot(-0.570) = 0.619\angle -112.9°$, plot point in complex plane either with rectangular coordinates or polar coordinates

2. $y = 1.170 - j\cdot 1.105$; $Z = Z_0 / (1.170 - j\cdot 1.105) = 22.588\Omega + j\cdot(21.3327)\Omega$

3. a) Pin = 2.50mW = 3.979dBm; Pc = 3.979dBm - 6.10dB = -2.121 dBm = 0.6137mW
Ideal lossless coupler: P_T = 2.50mW – 0.6137mW = 1.8863 mW= 2.756 dBm ; after amplifier G_1 we have $P_{A1} = P_T + G_1$ = 2.756 dBm + 8.9dB = 11.656 dBm ; inside the filter passband maximum attenuation introduced by the filter is equal to the ripple, $P_{out,max} = P_{A1}$ = 11.656 dBm = 14.64mW, $P_{out,min} = P_{A1} - R$ = 11.656 dBm – 1.3dB = 10.356 dBm = 10.855 mW
b) $P_{meas} = P_C + G_2$ = -2.121 dBm + 10.9dB = 8.779 dBm = 7.550 mW
c) Outside the passband $P_{out} = P_{A1} - A$ = 11.656 dBm – 19.4dB = -7.744 dBm = 0.168 mW

4. $\Gamma = (Z - Z_0)/(Z + Z_0) = 0.341 + j\cdot(-0.386) = 0.515\angle -48.588°$;
b) Complex calculus from L7/L8, 2 solutions for the match, $Z_0 = 50\Omega$ lines
$\theta_{S1} = 84.8°$; $Im(y_S) = -1.203$; $\theta_{p1} = 129.7°$ **and** $\theta_{S2} = 143.8°$; $Im(y_S) = 1.203$; $\theta_{p2} = 50.3°$
c) Obviously the shunt stub θ_p is towards the 50 ohm source

5. In any order we cascade the two devices the gain will be the same $G = G_1 + G_2$ = 9.6dB + 11.4dB = 21.0dB. The "best" placement for the two devices refers to the minimum noise factor.
F_1 = 1.24dB=1.330, F_2 = 0.92dB=1.236, G_1 = 9.6dB = 9.120, G_2 = 11.4dB = 13.804
We compute $F_{12} = F_1 + (F_2-1)/G_1 = 1.356$ and $F_{21} = F_2 + (F_1-1)/G_2 = 1.260$, we obtain a lower noise factor when we first use device 2 in the cascade. The result is F = 1.003dB and G = 21.0dB

6. a) The match for maximum gain is available only if the transistor is unconditionally stable.
$|S_{11}| = 0.600 < 1$; $|S_{22}| = 0.560 < 1$; $K = 1.192 > 1$; $|\Delta| = |(0.225) + j\cdot(-0.088)| = 0.242 < 1$
b) $B_1 = 0.988$; $C_1 = (-0.187) + j\cdot(0.445)$; $\Gamma_S = (-0.313) + j\cdot(-0.743) = 0.806\angle -112.8°$
$B_2 = 0.895$; $C_2 = (-0.434) + j\cdot(-0.026)$; $\Gamma_L = (-0.787) + j\cdot(0.047) = 0.788\angle 176.6°$
c) towards the source: $\theta_{s1} = 128.3°$; $\theta_{p1} = 110.1°$ **or** $\theta_{s2} = 164.5°$; $\theta_{p2} = 69.9°$
toward the load: $\theta_{s1} = 162.7°$; $\theta_{p1} = 111.3°$ **or** $\theta_{s2} = 20.7°$; $\theta_{p2} = 68.7°$

Subject no. 6

1. $Z = 21.02 + j\cdot(18.89)$; $\Gamma = (Z - Z_0)/(Z + Z_0) = -0.315 + j\cdot(0.350) = 0.471\angle 132.0°$, plot point in complex plane either with rectangular coordinates or polar coordinates

2. $y = 0.910 - j\cdot 1.225$; $Z = Z_0 / (0.910 - j\cdot 1.225) = 19.539\Omega + j\cdot(26.3019)\Omega$

3. a) Pin = 3.50mW = 5.441dBm; Pc = 5.441dBm - 6.55dB = -1.109 dBm = 0.7746mW
Ideal lossless coupler: P_T = 3.50mW – 0.7746mW = 2.7254 mW= 4.354 dBm ; after amplifier G_1 we have $P_{A1} = P_T + G_1$ = 4.354 dBm + 7.4dB = 11.754 dBm ; inside the filter passband maximum attenuation introduced by the filter is equal to the ripple, $P_{out,max} = P_{A1}$ = 11.754 dBm = 14.98mW, $P_{out,min} = P_{A1} - R$ = 11.754 dBm – 2.4dB = 9.354 dBm = 8.619 mW
b) $P_{meas} = P_C + G_2$ = -1.109 dBm + 10.9dB = 9.791 dBm = 9.529 mW
c) Outside the passband $P_{out} = P_{A1} - A$ = 11.754 dBm – 22.1dB = -10.346 dBm = 0.092 mW

4. $\Gamma = (Z - Z_0)/(Z + Z_0) = 0.179 + j\cdot(-0.325) = 0.371\angle -61.153°$;
b) Complex calculus from L7/L8, 2 solutions for the match, $Z_0 = 50\Omega$ lines
$\theta_{S1} = 86.5°$; $Im(y_S) = -0.799$; $\theta_{p1} = 141.4°$ **and** $\theta_{S2} = 154.7°$; $Im(y_S) = 0.799$; $\theta_{p2} = 38.6°$
c) Obviously the shunt stub θ_p is towards the 50 ohm source

5. In any order we cascade the two devices the gain will be the same $G = G_1 + G_2$ = 8.8dB + 11.1dB = 19.9dB. The "best" placement for the two devices refers to the minimum noise factor.
F_1 = 1.27dB=1.340, F_2 = 1.03dB=1.268, G_1 = 8.8dB = 7.586, G_2 = 11.1dB = 12.882
We compute $F_{12} = F_1 + (F_2-1)/G_1 = 1.375$ and $F_{21} = F_2 + (F_1-1)/G_2 = 1.294$, we obtain a lower noise factor when we first use device 2 in the cascade. The result is F = 1.119dB and G = 19.9dB

6. a) The match for maximum gain is available only if the transistor is unconditionally stable.
$|S_{11}| = 0.650 < 1$; $|S_{22}| = 0.520 < 1$; $K = 1.099 > 1$; $|\Delta| = |(-0.133) + j\cdot(0.247)| = 0.281 < 1$
b) $B_1 = 1.073$; $C_1 = (-0.526) + j\cdot(-0.072)$; $\Gamma_S = (-0.853) + j\cdot(0.117) = 0.861\angle 172.2°$
$B_2 = 0.769$; $C_2 = (-0.208) + j\cdot(-0.313)$; $\Gamma_L = (-0.448) + j\cdot(0.675) = 0.810\angle 123.6°$
c) towards the source: $\theta_{s1} = 168.6°$; $\theta_{p1} = 106.5°$ **or** $\theta_{s2} = 19.2°$; $\theta_{p2} = 73.5°$
toward the load: $\theta_{s1} = 10.3°$; $\theta_{p1} = 109.9°$ **or** $\theta_{s2} = 46.2°$; $\theta_{p2} = 70.1°$

Subject no. 7

1. $Z = 26.08 + j\cdot(11.33)$; $\Gamma = (Z - Z_0)/(Z + Z_0) = -0.286 + j\cdot(0.191) = 0.344\angle 146.2°$, plot point in complex plane either with rectangular coordinates or polar coordinates

2. $y = 0.750 - j\cdot 0.725$; $Z = Z_0 / (0.750 - j\cdot 0.725) = 34.463\Omega + j\cdot(33.3142)\Omega$

3. a) Pin = 3.45mW = 5.378dBm; Pc = 5.378dBm - 4.05dB = 1.328 dBm = 1.3577mW
Ideal lossless coupler: P_T = 3.45mW – 1.3577mW = 2.0923 mW= 3.206 dBm ; after amplifier G_1 we have $P_{A1} = P_T + G_1$ = 3.206 dBm + 8.1dB = 11.306 dBm ; inside the filter passband maximum attenuation introduced by the filter is equal to the ripple, $P_{out,max} = P_{A1}$ = 11.306 dBm = 13.51mW, $P_{out,min} = P_{A1} - R$ = 11.306 dBm – 1.6dB = 9.706 dBm = 9.346 mW
b) $P_{meas} = P_C + G_2$ = 1.328 dBm + 11.5dB = 12.828 dBm = 19.179 mW
c) Outside the passband $P_{out} = P_{A1} - A$ = 11.306 dBm – 20.2dB = -8.894 dBm = 0.129 mW

4. $\Gamma = (Z - Z_0)/(Z + Z_0) = 0.054 + j\cdot(-0.448) = 0.451\angle -83.061°$;
b) Complex calculus from L7/L8, 2 solutions for the match, $Z_0 = 50\Omega$ lines
$\theta_{S1} = 99.9°$; $Im(y_S) = -1.010$; $\theta_{p1} = 134.7°$ **and** $\theta_{S2} = 163.1°$; $Im(y_S) = 1.010$; $\theta_{p2} = 45.3°$
c) Obviously the shunt stub θ_p is towards the 50 ohm source

5. In any order we cascade the two devices the gain will be the same $G = G_1 + G_2$ = 9.7dB + 11.6dB = 21.3dB. The "best" placement for the two devices refers to the minimum noise factor.
F_1 = 1.10dB=1.288, F_2 = 0.95dB=1.245, G_1 = 9.7dB = 9.333, G_2 = 11.6dB = 14.454
We compute $F_{12} = F_1 + (F_2-1)/G_1 = 1.314$ and $F_{21} = F_2 + (F_1-1)/G_2 = 1.264$, we obtain a lower noise factor when we first use device 2 in the cascade. The result is F = 1.019dB and G = 21.3dB

6. a) The match for maximum gain is available only if the transistor is unconditionally stable.
$|S_{11}| = 0.638 < 1$; $|S_{22}| = 0.550 < 1$; $K = 1.197 > 1$; $|\Delta| = |(0.265) + j\cdot(0.072)| = 0.274 < 1$
b) $B_1 = 1.029$; $C_1 = (-0.358) + j\cdot(0.355)$; $\Gamma_S = (-0.583) + j\cdot(-0.578) = 0.821\angle -135.2°$
$B_2 = 0.820$; $C_2 = (-0.379) + j\cdot(-0.120)$; $\Gamma_L = (-0.742) + j\cdot(0.236) = 0.779\angle 162.4°$
c) towards the source: $\theta_{s1} = 140.2°$; $\theta_{p1} = 109.2°$ **or** $\theta_{s2} = 175.0°$; $\theta_{p2} = 70.8°$
toward the load: $\theta_{s1} = 169.4°$; $\theta_{p1} = 111.9°$ **or** $\theta_{s2} = 28.2°$; $\theta_{p2} = 68.1°$

Subject no. 8

1. $Z = 28.60 + j\cdot(-26.42)$; $\Gamma = (Z - Z_0)/(Z + Z_0) = -0.143 + j\cdot(-0.384) = 0.410\angle -110.4°$, plot point in complex plane either with rectangular coordinates or polar coordinates

2. $y = 1.165 - j\cdot 0.840$; $Z = Z_0 / (1.165 - j\cdot 0.840) = 28.238\Omega + j\cdot(20.3604)\Omega$

3. a) Pin = 3.30mW = 5.185dBm; Pc = 5.185dBm - 6.05dB = -0.865 dBm = 0.8194mW
Ideal lossless coupler: P_T = 3.30mW – 0.8194mW = 2.4806 mW= 3.946 dBm ; after amplifier G_1 we have $P_{A1} = P_T + G_1$ = 3.946 dBm + 9.9dB = 13.846 dBm ; inside the filter passband maximum attenuation introduced by the filter is equal to the ripple, $P_{out,max} = P_{A1}$ = 13.846 dBm = 24.24mW, $P_{out,min} = P_{A1} - R$ = 13.846 dBm – 0.8dB = 13.046 dBm = 20.163 mW
b) $P_{meas} = P_C + G_2$ = -0.865 dBm + 11.3dB = 10.435 dBm = 11.054 mW
c) Outside the passband $P_{out} = P_{A1} - A$ = 13.846 dBm – 24.3dB = -10.454 dBm = 0.090 mW

4. $\Gamma = (Z - Z_0)/(Z + Z_0) = 0.204 + j\cdot(-0.533) = 0.571\angle -69.067°$;
b) Complex calculus from L7/L8, 2 solutions for the match, $Z_0 = 50\Omega$ lines
$\theta_{S1} = 96.9°$; $Im(y_S) = -1.391$; $\theta_{p1} = 125.7°$ **and** $\theta_{S2} = 152.1°$; $Im(y_S) = 1.391$; $\theta_{p2} = 54.3°$
c) Obviously the shunt stub θ_p is towards the 50 ohm source

5. In any order we cascade the two devices the gain will be the same $G = G_1 + G_2$ = 8.5dB + 11.3dB = 19.8dB. The "best" placement for the two devices refers to the minimum noise factor.
F_1 = 1.12dB=1.294, F_2 = 0.91dB=1.233, G_1 = 8.5dB = 7.079, G_2 = 11.3dB = 13.490
We compute $F_{12} = F_1 + (F_2 - 1)/G_1 = 1.327$ and $F_{21} = F_2 + (F_1 - 1)/G_2 = 1.255$, we obtain a lower noise factor when we first use device 2 in the cascade. The result is F = 0.986dB and G = 19.8dB

6. a) The match for maximum gain is available only if the transistor is unconditionally stable.
$|S_{11}| = 0.602 < 1$; $|S_{22}| = 0.520 < 1$; $K = 1.180 > 1$; $|\Delta| = |(-0.026) + j\cdot(0.260)| = 0.261 < 1$
b) $B_1 = 1.024$; $C_1 = (-0.481) + j\cdot(0.131)$; $\Gamma_S = (-0.767) + j\cdot(-0.209) = 0.795\angle -164.8°$
$B_2 = 0.840$; $C_2 = (-0.247) + j\cdot(-0.320)$; $\Gamma_L = (-0.461) + j\cdot(0.597) = 0.754\angle 127.6°$
c) towards the source: $\theta_{s1} = 153.7°$; $\theta_{p1} = 110.9°$ **or** $\theta_{s2} = 11.1°$; $\theta_{p2} = 69.1°$
toward the load: $\theta_{s1} = 5.6°$; $\theta_{p1} = 113.5°$ **or** $\theta_{s2} = 46.7°$; $\theta_{p2} = 66.5°$

Subject no. 9

1. $Z = 15.56+ j\cdot(-29.63)$; $\Gamma = (Z - Z_0)/(Z + Z_0) = -0.267+ j\cdot(-0.573) = 0.632\angle-115.0°$, plot point in complex plane either with rectangular coordinates or polar coordinates

2. $y = 0.730 + j\cdot0.865$; $Z = Z_0 / (0.730 + j\cdot0.865) = 28.491\Omega + j\cdot(-33.7594)\Omega$

3. a) Pin = 3.65mW = 5.623dBm; Pc = 5.623dBm - 6.30dB = -0.677 dBm = 0.8556mW
Ideal lossless coupler: P_T = 3.65mW – 0.8556mW = 2.7944 mW= 4.463 dBm ; after amplifier G_1 we have $P_{A1} = P_T + G_1$ = 4.463 dBm + 7.4dB = 11.863 dBm ; inside the filter passband maximum attenuation introduced by the filter is equal to the ripple, $P_{out,max} = P_{A1}$ = 11.863 dBm = 15.36mW, $P_{out,min} = P_{A1} - R$ = 11.863 dBm – 1.2dB = 10.663 dBm = 11.649 mW
b) $P_{meas} = P_C + G_2$ = -0.677 dBm + 11.0dB = 10.323 dBm = 10.772 mW
c) Outside the passband $P_{out} = P_{A1} - A$ = 11.863 dBm – 18.1dB = -6.237 dBm = 0.238 mW

4. $\Gamma = (Z - Z_0)/(Z + Z_0) = 0.016 + j\cdot(0.419) = 0.419\angle87.879°$;
b) Complex calculus from L7/L8, 2 solutions for the match, $Z_0 = 50\Omega$ lines
$\theta_{S1} = 13.5°$; $Im(y_S) = -0.924$; $\theta_{p1} = 137.3°$ **and** $\theta_{S2} = 78.7°$; $Im(y_S) = 0.924$; $\theta_{p2} = 42.7°$
c) Obviously the shunt stub θ_p is towards the 50 ohm source

5. In any order we cascade the two devices the gain will be the same $G = G_1 + G_2$ = 8.4dB + 11.4dB = 19.8dB. The "best" placement for the two devices refers to the minimum noise factor.
F_1 = 1.22dB=1.324, F_2 = 0.97dB=1.250, G_1 = 8.4dB = 6.918, G_2 = 11.4dB = 13.804
We compute $F_{12} = F_1 + (F_2-1)/G_1 = 1.361$ and $F_{21} = F_2 + (F_1-1)/G_2 = 1.274$, we obtain a lower noise factor when we first use device 2 in the cascade. The result is F = 1.051dB and G = 19.8dB

6. a) The match for maximum gain is available only if the transistor is unconditionally stable.
$|S_{11}| = 0.632 < 1$; $|S_{22}| = 0.520 < 1$; $K = 1.106 > 1$; $|\Delta| = |(-0.111)+ j\cdot(0.257)| = 0.280 < 1$
b) $B_1 = 1.051$; $C_1 = (-0.518) + j\cdot(0.008)$; $\Gamma_S = (-0.845) + j\cdot(-0.013) = 0.845\angle-179.1°$
$B_2 = 0.792$; $C_2 = (-0.216) + j\cdot(-0.321)$; $\Gamma_L = (-0.446) + j\cdot(0.663) = 0.799\angle123.9°$
c) towards the source: $\theta_{s1} = 163.4°$; $\theta_{p1} = 107.5°$ **or** $\theta_{s2} = 15.7°$; $\theta_{p2} = 72.5°$
toward the load: $\theta_{s1} = 9.6°$; $\theta_{p1} = 110.6°$ **or** $\theta_{s2} = 46.5°$; $\theta_{p2} = 69.4°$

Subject no. 10

1. $Z = 27.89 + j\cdot(-21.20)$; $\Gamma = (Z - Z_0)/(Z + Z_0) = -0.195 + j\cdot(-0.325) = 0.379\angle -121.0°$, plot point in complex plane either with rectangular coordinates or polar coordinates

2. $y = 0.950 + j\cdot 1.100$; $Z = Z_0 / (0.950 + j\cdot 1.100) = 22.485\Omega + j\cdot(-26.0355)\Omega$

3. a) Pin = 1.50mW = 1.761dBm; Pc = 1.761dBm - 4.40dB = -2.639 dBm = 0.5446mW
Ideal lossless coupler: P_T = 1.50mW – 0.5446mW = 0.9554 mW= -0.198 dBm ; after amplifier G_1 we have $P_{A1} = P_T + G_1$ = -0.198 dBm + 9.3dB = 9.102 dBm ; inside the filter passband maximum attenuation introduced by the filter is equal to the ripple, $P_{out,max} = P_{A1}$ = 9.102 dBm = 8.13mW, $P_{out,min} = P_{A1} - R$ = 9.102 dBm – 1.0dB = 8.102 dBm = 6.459 mW
b) $P_{meas} = P_C + G_2$ = -2.639 dBm + 10.2dB = 7.561 dBm = 5.703 mW
c) Outside the passband $P_{out} = P_{A1} - A$ = 9.102 dBm – 19.7dB = -10.598 dBm = 0.087 mW

4. $\Gamma = (Z - Z_0)/(Z + Z_0) = 0.218 + j\cdot(-0.461) = 0.510\angle -64.713°$;
b) Complex calculus from L7/L8, 2 solutions for the match, $Z_0 = 50\Omega$ lines
$\theta_{S1} = 92.7°$; $Im(y_S) = -1.185$; $\theta_{p1} = 130.2°$ **and** $\theta_{S2} = 152.0°$; $Im(y_S) = 1.185$; $\theta_{p2} = 49.8°$
c) Obviously the shunt stub θ_p is towards the 50 ohm source

5. In any order we cascade the two devices the gain will be the same $G = G_1 + G_2$ = 8.1dB + 10.3dB = 18.4dB. The "best" placement for the two devices refers to the minimum noise factor.
F_1 = 1.16dB=1.306, F_2 = 1.04dB=1.271, G_1 = 8.1dB = 6.457, G_2 = 10.3dB = 10.715
We compute $F_{12} = F_1 + (F_2 - 1)/G_1 = 1.348$ and $F_{21} = F_2 + (F_1 - 1)/G_2 = 1.299$, we obtain a lower noise factor when we first use device 2 in the cascade. The result is F = 1.137dB and G = 18.4dB

6. a) The match for maximum gain is available only if the transistor is unconditionally stable.
$|S_{11}| = 0.640 < 1$; $|S_{22}| = 0.550 < 1$; $K = 1.189 > 1$; $|\Delta| = |(0.262) + j\cdot(0.095)| = 0.279 < 1$
b) $B_1 = 1.029$; $C_1 = (-0.373) + j\cdot(0.340)$; $\Gamma_S = (-0.608) + j\cdot(-0.555) = 0.823\angle -137.6°$
$B_2 = 0.815$; $C_2 = (-0.374) + j\cdot(-0.129)$; $\Gamma_L = (-0.738) + j\cdot(0.254) = 0.780\angle 161.0°$
c) towards the source: $\theta_{s1} = 141.5°$; $\theta_{p1} = 109.0°$ **or** $\theta_{s2} = 176.1°$; $\theta_{p2} = 71.0°$
toward the load: $\theta_{s1} = 170.1°$; $\theta_{p1} = 111.8°$ **or** $\theta_{s2} = 28.9°$; $\theta_{p2} = 68.2°$

Subject no. 11

1. $Z = 18.85 + j\cdot(19.97)$; $\Gamma = (Z - Z_0)/(Z + Z_0) = -0.340 + j\cdot(0.389) = 0.516\angle 131.2°$, plot point in complex plane either with rectangular coordinates or polar coordinates

2. $y = 1.225 + j\cdot 1.200$; $Z = Z_0 / (1.225 + j\cdot 1.200) = 20.829\Omega + j\cdot(-20.4038)\Omega$

3. a) Pin = 2.65mW = 4.232dBm; Pc = 4.232dBm - 4.80dB = -0.568 dBm = 0.8775mW
Ideal lossless coupler: P_T = 2.65mW – 0.8775mW = 1.7725 mW= 2.486 dBm ; after amplifier G_1 we have $P_{A1} = P_T + G_1$ = 2.486 dBm + 7.4dB = 9.886 dBm ; inside the filter passband maximum attenuation introduced by the filter is equal to the ripple, $P_{out,max} = P_{A1}$ = 9.886 dBm = 9.74mW, $P_{out,min} = P_{A1} - R$ = 9.886 dBm – 2.3dB = 7.586 dBm = 5.736 mW
b) $P_{meas} = P_C + G_2$ = -0.568 dBm + 8.0dB = 7.432 dBm = 5.537 mW
c) Outside the passband $P_{out} = P_{A1} - A$ = 9.886 dBm – 17.3dB = -7.414 dBm = 0.181 mW

4. $\Gamma = (Z - Z_0)/(Z + Z_0) = 0.205 + j\cdot(0.415) = 0.463\angle 63.756°$;
b) Complex calculus from L7/L8, 2 solutions for the match, $Z_0 = 50\Omega$ lines
$\theta_{S1} = 26.9°$; $Im(y_S) = -1.045$; $\theta_{p1} = 133.7°$ **and** $\theta_{S2} = 89.3°$; $Im(y_S) = 1.045$; $\theta_{p2} = 46.3°$
c) Obviously the shunt stub θ_p is towards the 50 ohm source

5. In any order we cascade the two devices the gain will be the same $G = G_1 + G_2$ = 9.1dB + 10.7dB = 19.8dB. The "best" placement for the two devices refers to the minimum noise factor.
F_1 = 1.29dB=1.346, F_2 = 1.04dB=1.271, G_1 = 9.1dB = 8.128, G_2 = 10.7dB = 11.749
We compute $F_{12} = F_1 + (F_2 - 1)/G_1 = 1.379$ and $F_{21} = F_2 + (F_1 - 1)/G_2 = 1.300$, we obtain a lower noise factor when we first use device 2 in the cascade. The result is F = 1.139dB and G = 19.8dB

6. a) The match for maximum gain is available only if the transistor is unconditionally stable.
$|S_{11}| = 0.644 < 1$; $|S_{22}| = 0.520 < 1$; $K = 1.101 > 1$; $|\Delta| = |(-0.126) + j\cdot(0.250)| = 0.280 < 1$
b) $B_1 = 1.066$; $C_1 = (-0.525) + j\cdot(-0.045)$; $\Gamma_S = (-0.853) + j\cdot(0.073) = 0.856\angle 175.1°$
$B_2 = 0.777$; $C_2 = (-0.211) + j\cdot(-0.316)$; $\Gamma_L = (-0.447) + j\cdot(0.671) = 0.807\angle 123.7°$
c) towards the source: $\theta_{s1} = 166.9°$; $\theta_{p1} = 106.8°$ **or** $\theta_{s2} = 18.0°$; $\theta_{p2} = 73.2°$
toward the load: $\theta_{s1} = 10.0°$; $\theta_{p1} = 110.1°$ **or** $\theta_{s2} = 46.3°$; $\theta_{p2} = 69.9°$

Subject no. 12

1. $Z = 21.29 + j\cdot(-17.08)$; $\Gamma = (Z - Z_0)/(Z + Z_0) = -0.327 + j\cdot(-0.318) = 0.456\angle -135.8°$, plot point in complex plane either with rectangular coordinates or polar coordinates

2. $y = 1.015 - j\cdot 0.710$; $Z = Z_0 / (1.015 - j\cdot 0.710) = 33.076\Omega + j\cdot(23.1372)\Omega$

3. a) Pin = 2.25mW = 3.522dBm; Pc = 3.522dBm - 6.65dB = -3.128 dBm = 0.4866mW
Ideal lossless coupler: P_T = 2.25mW – 0.4866mW = 1.7634 mW= 2.463 dBm ; after amplifier G_1 we have $P_{A1} = P_T + G_1$ = 2.463 dBm + 9.6dB = 12.063 dBm ; inside the filter passband maximum attenuation introduced by the filter is equal to the ripple, $P_{out,max} = P_{A1}$ = 12.063 dBm = 16.08mW, $P_{out,min} = P_{A1} - R$ = 12.063 dBm – 1.6dB = 10.463 dBm = 11.126 mW
b) $P_{meas} = P_C + G_2$ = -3.128 dBm + 8.2dB = 5.072 dBm = 3.215 mW
c) Outside the passband $P_{out} = P_{A1} - A$ = 12.063 dBm – 15.1dB = -3.037 dBm = 0.497 mW

4. $\Gamma = (Z - Z_0)/(Z + Z_0) = 0.251 + j\cdot(0.394) = 0.467\angle 57.564°$;
b) Complex calculus from L7/L8, 2 solutions for the match, $Z_0 = 50\Omega$ lines
$\theta_{S1} = 30.1°$; $Im(y_S) = -1.057$; $\theta_{p1} = 133.4°$ **and** $\theta_{S2} = 92.3°$; $Im(y_S) = 1.057$; $\theta_{p2} = 46.6°$
c) Obviously the shunt stub θ_p is towards the 50 ohm source

5. In any order we cascade the two devices the gain will be the same $G = G_1 + G_2$ = 9.2dB + 10.6dB = 19.8dB. The "best" placement for the two devices refers to the minimum noise factor.
F_1 = 1.16dB=1.306, F_2 = 1.07dB=1.279, G_1 = 9.2dB = 8.318, G_2 = 10.6dB = 11.482
We compute $F_{12} = F_1 + (F_2-1)/G_1 = 1.340$ and $F_{21} = F_2 + (F_1-1)/G_2 = 1.306$, we obtain a lower noise factor when we first use device 2 in the cascade. The result is F = 1.160dB and G = 19.8dB

6. a) The match for maximum gain is available only if the transistor is unconditionally stable.
$|S_{11}| = 0.638 < 1$; $|S_{22}| = 0.520 < 1$; $K = 1.103 > 1$; $|\Delta| = |(-0.118) + j\cdot(0.254)| = 0.280 < 1$
b) $B_1 = 1.058$; $C_1 = (-0.522) + j\cdot(-0.018)$; $\Gamma_S = (-0.850) + j\cdot(0.030) = 0.851\angle 178.0°$
$B_2 = 0.785$; $C_2 = (-0.213) + j\cdot(-0.318)$; $\Gamma_L = (-0.447) + j\cdot(0.667) = 0.803\angle 123.8°$
c) towards the source: $\theta_{s1} = 165.2°$; $\theta_{p1} = 107.2°$ **or** $\theta_{s2} = 16.9°$; $\theta_{p2} = 72.8°$
toward the load: $\theta_{s1} = 9.8°$; $\theta_{p1} = 110.4°$ **or** $\theta_{s2} = 46.4°$; $\theta_{p2} = 69.6°$

Subject no. 13

1. $Z = 25.13 + j\cdot(-25.00)$; $\Gamma = (Z - Z_0)/(Z + Z_0) = -0.198 + j\cdot(-0.399) = 0.445\angle -116.4°$, plot point in complex plane either with rectangular coordinates or polar coordinates

2. $y = 0.910 - j\cdot 0.810$; $Z = Z_0 / (0.910 - j\cdot 0.810) = 30.656\Omega + j\cdot(27.2874)\Omega$

3. a) Pin = 1.85mW = 2.672dBm; Pc = 2.672dBm - 6.45dB = -3.778 dBm = 0.4190mW
Ideal lossless coupler: P_T = 1.85mW – 0.4190mW = 1.4310 mW= 1.557 dBm ; after amplifier G_1 we have $P_{A1} = P_T + G_1$ = 1.557 dBm + 6.5dB = 8.057 dBm ; inside the filter passband maximum attenuation introduced by the filter is equal to the ripple, $P_{out,max} = P_{A1}$ = 8.057 dBm = 6.39mW, $P_{out,min} = P_{A1} - R$ = 8.057 dBm – 1.1dB = 6.957 dBm = 4.962 mW
b) $P_{meas} = P_C + G_2$ = -3.778 dBm + 9.9dB = 6.122 dBm = 4.094 mW
c) Outside the passband $P_{out} = P_{A1} - A$ = 8.057 dBm – 16.4dB = -8.343 dBm = 0.146 mW

4. $\Gamma = (Z - Z_0)/(Z + Z_0) = 0.185 + j\cdot(-0.301) = 0.353\angle -58.386°$;
b) Complex calculus from L7/L8, 2 solutions for the match, $Z_0 = 50\Omega$ lines
$\theta_{S1} = 84.5°$; $Im(y_S) = -0.756$; $\theta_{p1} = 142.9°$ **and** $\theta_{S2} = 153.8°$; $Im(y_S) = 0.756$; $\theta_{p2} = 37.1°$
c) Obviously the shunt stub θ_p is towards the 50 ohm source

5. In any order we cascade the two devices the gain will be the same $G = G_1 + G_2$ = 8.0dB + 10.8dB = 18.8dB. The "best" placement for the two devices refers to the minimum noise factor.
F_1 = 1.18dB=1.312, F_2 = 0.98dB=1.253, G_1 = 8.0dB = 6.310, G_2 = 10.8dB = 12.023
We compute $F_{12} = F_1 + (F_2-1)/G_1 = 1.352$ and $F_{21} = F_2 + (F_1-1)/G_2 = 1.279$, we obtain a lower noise factor when we first use device 2 in the cascade. The result is F = 1.069dB and G = 18.8dB

6. a) The match for maximum gain is available only if the transistor is unconditionally stable.
$|S_{11}| = 0.640 < 1$; $|S_{22}| = 0.550 < 1$; $K = 1.182 > 1$; $|\Delta| = |(0.246) + j\cdot(0.141)| = 0.284 < 1$
b) $B_1 = 1.026$; $C_1 = (-0.400) + j\cdot(0.307)$; $\Gamma_S = (-0.653) + j\cdot(-0.502) = 0.824\angle -142.5°$
$B_2 = 0.812$; $C_2 = (-0.364) + j\cdot(-0.151)$; $\Gamma_L = (-0.722) + j\cdot(0.299) = 0.781\angle 157.5°$
c) towards the source: $\theta_{s1} = 144.0°$; $\theta_{p1} = 109.0°$ **or** $\theta_{s2} = 178.5°$; $\theta_{p2} = 71.0°$
toward the load: $\theta_{s1} = 171.9°$; $\theta_{p1} = 111.8°$ **or** $\theta_{s2} = 30.6°$; $\theta_{p2} = 68.2°$

Subject no. 14

1. $Z = 52.00 + j\cdot(33.46)$; $\Gamma = (Z - Z_0)/(Z + Z_0) = 0.115 + j\cdot(0.290) = 0.312\angle 68.4°$, plot point in complex plane either with rectangular coordinates or polar coordinates

2. $y = 1.040 + j\cdot 1.085$; $Z = Z_0 / (1.040 + j\cdot 1.085) = 23.021\Omega + j\cdot(-24.0169)\Omega$

3. a) Pin = 2.30mW = 3.617dBm; Pc = 3.617dBm - 4.10dB = -0.483 dBm = 0.8948mW
Ideal lossless coupler: P_T = 2.30mW – 0.8948mW = 1.4052 mW= 1.477 dBm ; after amplifier G_1 we have $P_{A1} = P_T + G_1$ = 1.477 dBm + 7.9dB = 9.377 dBm ; inside the filter passband maximum attenuation introduced by the filter is equal to the ripple, $P_{out,max} = P_{A1}$ = 9.377 dBm = 8.66mW, $P_{out,min} = P_{A1} - R$ = 9.377 dBm – 2.2dB = 7.177 dBm = 5.221 mW
b) $P_{meas} = P_C + G_2$ = -0.483 dBm + 8.2dB = 7.717 dBm = 5.912 mW
c) Outside the passband $P_{out} = P_{A1} - A$ = 9.377 dBm – 15.3dB = -5.923 dBm = 0.256 mW

4. $\Gamma = (Z - Z_0)/(Z + Z_0) = 0.289 + j\cdot(-0.349) = 0.453\angle -50.331°$;
b) Complex calculus from L7/L8, 2 solutions for the match, $Z_0 = 50\Omega$ lines
$\theta_{S1} = 83.6°$; $Im(y_S) = -1.016$; $\theta_{p1} = 134.6°$ **and** $\theta_{S2} = 146.7°$; $Im(y_S) = 1.016$; $\theta_{p2} = 45.4°$
c) Obviously the shunt stub θ_p is towards the 50 ohm source

5. In any order we cascade the two devices the gain will be the same $G = G_1 + G_2$ = 8.1dB + 10.6dB = 18.7dB. The "best" placement for the two devices refers to the minimum noise factor.
F_1 = 1.18dB=1.312, F_2 = 1.05dB=1.274, G_1 = 8.1dB = 6.457, G_2 = 10.6dB = 11.482
We compute $F_{12} = F_1 + (F_2 - 1)/G_1 = 1.355$ and $F_{21} = F_2 + (F_1 - 1)/G_2 = 1.301$, we obtain a lower noise factor when we first use device 2 in the cascade. The result is F = 1.142dB and G = 18.7dB

6. a) The match for maximum gain is available only if the transistor is unconditionally stable.
$|S_{11}| = 0.640 < 1$; $|S_{22}| = 0.550 < 1$; $K = 1.181 > 1$; $|\Delta| = |(0.241) + j\cdot(0.152)| = 0.285 < 1$
b) $B_1 = 1.026$; $C_1 = (-0.406) + j\cdot(0.298)$; $\Gamma_S = (-0.664) + j\cdot(-0.488) = 0.824\angle -143.7°$
$B_2 = 0.812$; $C_2 = (-0.361) + j\cdot(-0.156)$; $\Gamma_L = (-0.717) + j\cdot(0.310) = 0.781\angle 156.6°$
c) towards the source: $\theta_{s1} = 144.6°$; $\theta_{p1} = 109.0°$ **or** $\theta_{s2} = 179.1°$; $\theta_{p2} = 71.0°$
toward the load: $\theta_{s1} = 172.4°$; $\theta_{p1} = 111.8°$ **or** $\theta_{s2} = 31.0°$; $\theta_{p2} = 68.2°$

Subject no. 15

1. $Z = 17.85+ j\cdot(-30.80)$; $\Gamma = (Z - Z_0)/(Z + Z_0) = -0.222+ j\cdot(-0.555) = 0.597\angle-111.8°$, plot point in complex plane either with rectangular coordinates or polar coordinates

2. $y = 0.950 + j\cdot1.275$; $Z = Z_0 / (0.950 + j\cdot1.275) = 18.789\Omega + j\cdot(-25.2163)\Omega$

3. a) Pin = 2.30mW = 3.617dBm; Pc = 3.617dBm - 4.60dB = -0.983 dBm = 0.7975mW
Ideal lossless coupler: P_T = 2.30mW – 0.7975mW = 1.5025 mW= 1.768 dBm ; after amplifier G_1 we have $P_{A1} = P_T + G_1$ = 1.768 dBm + 7.1dB = 8.868 dBm ; inside the filter passband maximum attenuation introduced by the filter is equal to the ripple, $P_{out,max} = P_{A1}$ = 8.868 dBm = 7.71mW, $P_{out,min} = P_{A1} - R$ = 8.868 dBm – 2.1dB = 6.768 dBm = 4.751 mW
b) $P_{meas} = P_C + G_2$ = -0.983 dBm + 10.2dB = 9.217 dBm = 8.351 mW
c) Outside the passband $P_{out} = P_{A1} - A$ = 8.868 dBm – 18.5dB = -9.632 dBm = 0.109 mW

4. $\Gamma = (Z - Z_0)/(Z + Z_0) = 0.118 + j\cdot(-0.294) = 0.317\angle-68.048°$;
b) Complex calculus from L7/L8, 2 solutions for the match, $Z_0 = 50\Omega$ lines
$\theta_{S1} = 88.3°$; $Im(y_S) = -0.667$; $\theta_{p1} = 146.3°$ **and** $\theta_{S2} = 159.8°$; $Im(y_S) = 0.667$; $\theta_{p2} = 33.7°$
c) Obviously the shunt stub θ_p is towards the 50 ohm source

5. In any order we cascade the two devices the gain will be the same $G = G_1 + G_2$ = 8.9dB + 10.2dB = 19.1dB. The "best" placement for the two devices refers to the minimum noise factor.
F_1 = 1.27dB=1.340, F_2 = 1.08dB=1.282, G_1 = 8.9dB = 7.762, G_2 = 10.2dB = 10.471
We compute $F_{12} = F_1 + (F_2-1)/G_1 = 1.376$ and $F_{21} = F_2 + (F_1-1)/G_2 = 1.315$, we obtain a lower noise factor when we first use device 2 in the cascade. The result is F = 1.188dB and G = 19.1dB

6. a) The match for maximum gain is available only if the transistor is unconditionally stable.
$|S_{11}| = 0.620 < 1$; $|S_{22}| = 0.520 < 1$; $K = 1.114 > 1$; $|\Delta| = |(-0.096)+ j\cdot(0.264)| = 0.281 < 1$
b) $B_1 = 1.035$; $C_1 = (-0.506) + j\cdot(0.059)$; $\Gamma_S = (-0.827) + j\cdot(-0.097) = 0.833\angle-173.3°$
$B_2 = 0.807$; $C_2 = (-0.220) + j\cdot(-0.325)$; $\Gamma_L = (-0.443) + j\cdot(0.654) = 0.790\angle124.1°$
c) towards the source: $\theta_{s1} = 159.9°$; $\theta_{p1} = 108.4°$ **or** $\theta_{s2} = 13.5°$; $\theta_{p2} = 71.6°$
toward the load: $\theta_{s1} = 9.0°$; $\theta_{p1} = 111.2°$ **or** $\theta_{s2} = 46.9°$; $\theta_{p2} = 68.8°$

Subject no. 16

1. $Z = 20.49 + j\cdot(18.94)$; $\Gamma = (Z - Z_0)/(Z + Z_0) = -0.323 + j\cdot(0.356) = 0.480\angle 132.3°$, plot point in complex plane either with rectangular coordinates or polar coordinates

2. $y = 0.855 + j\cdot 1.275$; $Z = Z_0 / (0.855 + j\cdot 1.275) = 18.140\Omega + j\cdot(-27.0511)\Omega$

3. a) Pin = 1.60mW = 2.041dBm; Pc = 2.041dBm - 6.90dB = -4.859 dBm = 0.3267mW
Ideal lossless coupler: P_T = 1.60mW – 0.3267mW = 1.2733 mW= 1.049 dBm ; after amplifier G_1 we have $P_{A1} = P_T + G_1$ = 1.049 dBm + 8.3dB = 9.349 dBm ; inside the filter passband maximum attenuation introduced by the filter is equal to the ripple, $P_{out,max} = P_{A1}$ = 9.349 dBm = 8.61mW, $P_{out,min} = P_{A1} - R$ = 9.349 dBm – 2.2dB = 7.149 dBm = 5.187 mW
b) $P_{meas} = P_C + G_2$ = -4.859 dBm + 9.6dB = 4.741 dBm = 2.979 mW
c) Outside the passband $P_{out} = P_{A1} - A$ = 9.349 dBm – 21.7dB = -12.351 dBm = 0.058 mW

4. $\Gamma = (Z - Z_0)/(Z + Z_0) = 0.339 + j\cdot(-0.353) = 0.490\angle -46.099°$;
b) Complex calculus from L7/L8, 2 solutions for the match, $Z_0 = 50\Omega$ lines
$\theta_{S1} = 82.7°$; $Im(y_S) = -1.123$; $\theta_{p1} = 131.7°$ **and** $\theta_{S2} = 143.4°$; $Im(y_S) = 1.123$; $\theta_{p2} = 48.3°$
c) Obviously the shunt stub θ_p is towards the 50 ohm source

5. In any order we cascade the two devices the gain will be the same $G = G_1 + G_2$ = 9.9dB + 10.3dB = 20.2dB. The "best" placement for the two devices refers to the minimum noise factor.
F_1 = 1.15dB=1.303, F_2 = 1.07dB=1.279, G_1 = 9.9dB = 9.772, G_2 = 10.3dB = 10.715
We compute $F_{12} = F_1 + (F_2-1)/G_1 = 1.332$ and $F_{21} = F_2 + (F_1-1)/G_2 = 1.308$, we obtain a lower noise factor when we first use device 2 in the cascade. The result is F = 1.165dB and G = 20.2dB

6. a) The match for maximum gain is available only if the transistor is unconditionally stable.
$|S_{11}| = 0.609 < 1$; $|S_{22}| = 0.557 < 1$; $K = 1.203 > 1$; $|\Delta| = |(0.236) + j\cdot(-0.069)| = 0.246 < 1$
b) $B_1 = 1.000$; $C_1 = (-0.220) + j\cdot(0.437)$; $\Gamma_S = (-0.363) + j\cdot(-0.721) = 0.807\angle -116.7°$
$B_2 = 0.879$; $C_2 = (-0.424) + j\cdot(-0.045)$; $\Gamma_L = (-0.779) + j\cdot(0.082) = 0.783\angle 174.0°$
c) towards the source: $\theta_{s1} = 130.3°$; $\theta_{p1} = 110.1°$ **or** $\theta_{s2} = 166.4°$; $\theta_{p2} = 69.9°$
toward the load: $\theta_{s1} = 163.8°$; $\theta_{p1} = 111.7°$ **or** $\theta_{s2} = 22.3°$; $\theta_{p2} = 68.3°$

Subject no. 17

1. $Z = 60.00 + j\cdot(-71.45)$; $\Gamma = (Z - Z_0)/(Z + Z_0) = 0.361 + j\cdot(-0.415) = 0.550\angle -49.0°$, plot point in complex plane either with rectangular coordinates or polar coordinates

2. $y = 0.735 + j\cdot 0.905$; $Z = Z_0 / (0.735 + j\cdot 0.905) = 27.037\Omega + j\cdot(-33.2904)\Omega$

3. a) Pin = 1.30mW = 1.139dBm; Pc = 1.139dBm - 5.75dB = -4.611 dBm = 0.3459mW
Ideal lossless coupler: P_T = 1.30mW – 0.3459mW = 0.9541 mW= -0.204 dBm ; after amplifier G_1 we have $P_{A1} = P_T + G_1$ = -0.204 dBm + 8.9dB = 8.696 dBm ; inside the filter passband maximum attenuation introduced by the filter is equal to the ripple, $P_{out,max} = P_{A1}$ = 8.696 dBm = 7.41mW, $P_{out,min} = P_{A1} - R$ = 8.696 dBm – 0.7dB = 7.996 dBm = 6.304 mW
b) $P_{meas} = P_C + G_2$ = -4.611 dBm + 10.3dB = 5.689 dBm = 3.706 mW
c) Outside the passband $P_{out} = P_{A1} - A$ = 8.696 dBm – 17.5dB = -8.804 dBm = 0.132 mW

4. $\Gamma = (Z - Z_0)/(Z + Z_0) = 0.213 + j\cdot(-0.437) = 0.486\angle -64.045°$;
b) Complex calculus from L7/L8, 2 solutions for the match, $Z_0 = 50\Omega$ lines
$\theta_{S1} = 91.6°$; $Im(y_S) = -1.112$; $\theta_{p1} = 132.0°$ **and** $\theta_{S2} = 152.5°$; $Im(y_S) = 1.112$; $\theta_{p2} = 48.0°$
c) Obviously the shunt stub θ_p is towards the 50 ohm source

5. In any order we cascade the two devices the gain will be the same $G = G_1 + G_2$ = 8.7dB + 10.5dB = 19.2dB. The "best" placement for the two devices refers to the minimum noise factor.
F_1 = 1.23dB=1.327, F_2 = 1.08dB=1.282, G_1 = 8.7dB = 7.413, G_2 = 10.5dB = 11.220
We compute $F_{12} = F_1 + (F_2-1)/G_1 = 1.365$ and $F_{21} = F_2 + (F_1-1)/G_2 = 1.312$, we obtain a lower noise factor when we first use device 2 in the cascade. The result is F = 1.178dB and G = 19.2dB

6. a) The match for maximum gain is available only if the transistor is unconditionally stable.
$|S_{11}| = 0.634 < 1$; $|S_{22}| = 0.550 < 1$; $K = 1.213 > 1$; $|\Delta| = |(0.264) + j\cdot(0.026)| = 0.265 < 1$
b) $B_1 = 1.029$; $C_1 = (-0.327) + j\cdot(0.383)$; $\Gamma_S = (-0.530) + j\cdot(-0.620) = 0.815\angle -130.5°$
$B_2 = 0.830$; $C_2 = (-0.389) + j\cdot(-0.103)$; $\Gamma_L = (-0.749) + j\cdot(0.199) = 0.775\angle 165.1°$
c) towards the source: $\theta_{s1} = 137.6°$; $\theta_{p1} = 109.5°$ **or** $\theta_{s2} = 172.9°$; $\theta_{p2} = 70.5°$
toward the load: $\theta_{s1} = 167.8°$; $\theta_{p1} = 112.2°$ **or** $\theta_{s2} = 27.0°$; $\theta_{p2} = 67.8°$

Subject no. 18

1. $Z = 36.00 + j\cdot(54.03)$; $\Gamma = (Z - Z_0)/(Z + Z_0) = 0.166 + j\cdot(0.524) = 0.550\angle 72.4°$, plot point in complex plane either with rectangular coordinates or polar coordinates

2. $y = 0.890 + j\cdot 1.110$; $Z = Z_0 / (0.890 + j\cdot 1.110) = 21.984\Omega + j\cdot(-27.4182)\Omega$

3. a) Pin = 1.95mW = 2.900dBm; Pc = 2.900dBm - 6.10dB = -3.200 dBm = 0.4787mW
Ideal lossless coupler: P_T = 1.95mW – 0.4787mW = 1.4713 mW= 1.677 dBm ; after amplifier G_1 we have $P_{A1} = P_T + G_1$ = 1.677 dBm + 8.7dB = 10.377 dBm ; inside the filter passband maximum attenuation introduced by the filter is equal to the ripple, $P_{out,max} = P_{A1}$ = 10.377 dBm = 10.91mW, $P_{out,min} = P_{A1} - R$ = 10.377 dBm – 2.9dB = 7.477 dBm = 5.594 mW
b) $P_{meas} = P_C + G_2$ = -3.200 dBm + 8.5dB = 5.300 dBm = 3.389 mW
c) Outside the passband $P_{out} = P_{A1} - A$ = 10.377 dBm – 17.5dB = -7.123 dBm = 0.194 mW

4. $\Gamma = (Z - Z_0)/(Z + Z_0) = 0.289 + j\cdot(0.440) = 0.527\angle 56.677°$;
b) Complex calculus from L7/L8, 2 solutions for the match, $Z_0 = 50\Omega$ lines
$\theta_{S1} = 32.6°$; $Im(y_S) = -1.240$; $\theta_{p1} = 128.9°$ **and** $\theta_{S2} = 90.8°$; $Im(y_S) = 1.240$; $\theta_{p2} = 51.1°$
c) Obviously the shunt stub θ_p is towards the 50 ohm source

5. In any order we cascade the two devices the gain will be the same $G = G_1 + G_2$ = 9.5dB + 10.3dB = 19.8dB. The "best" placement for the two devices refers to the minimum noise factor.
F_1 = 1.25dB=1.334, F_2 = 0.98dB=1.253, G_1 = 9.5dB = 8.913, G_2 = 10.3dB = 10.715
We compute $F_{12} = F_1 + (F_2-1)/G_1 = 1.362$ and $F_{21} = F_2 + (F_1-1)/G_2 = 1.284$, we obtain a lower noise factor when we first use device 2 in the cascade. The result is F = 1.087dB and G = 19.8dB

6. a) The match for maximum gain is available only if the transistor is unconditionally stable.
$|S_{11}| = 0.662 < 1$; $|S_{22}| = 0.516 < 1$; $K = 1.066 > 1$; $|\Delta| = |(-0.198) + j\cdot(0.223)| = 0.298 < 1$
b) $B_1 = 1.083$; $C_1 = (-0.525) + j\cdot(-0.116)$; $\Gamma_S = (-0.862) + j\cdot(0.191) = 0.883\angle 167.5°$
$B_2 = 0.739$; $C_2 = (-0.171) + j\cdot(-0.321)$; $\Gamma_L = (-0.392) + j\cdot(0.735) = 0.833\angle 118.1°$
c) towards the source: $\theta_{s1} = 172.3°$; $\theta_{p1} = 104.9°$ **or** $\theta_{s2} = 20.2°$; $\theta_{p2} = 75.1°$
toward the load: $\theta_{s1} = 14.2°$; $\theta_{p1} = 108.4°$ **or** $\theta_{s2} = 47.8°$; $\theta_{p2} = 71.6°$

Subject no. 19

1. $Z = 51.00 + j\cdot(-34.54)$; $\Gamma = (Z - Z_0)/(Z + Z_0) = 0.114 + j\cdot(-0.303) = 0.324\angle{-69.5}°$, plot point in complex plane either with rectangular coordinates or polar coordinates

2. $y = 0.825 + j\cdot1.280$; $Z = Z_0 / (0.825 + j\cdot1.280) = 17.788\Omega + j\cdot(-27.5978)\Omega$

3. a) Pin = 2.00mW = 3.010dBm; Pc = 3.010dBm - 6.50dB = -3.490 dBm = 0.4477mW
Ideal lossless coupler: P_T = 2.00mW – 0.4477mW = 1.5523 mW= 1.910 dBm ; after amplifier G_1 we have $P_{A1} = P_T + G_1$ = 1.910 dBm + 9.5dB = 11.410 dBm ; inside the filter passband maximum attenuation introduced by the filter is equal to the ripple, $P_{out,max} = P_{A1}$ = 11.410 dBm = 13.83mW, $P_{out,min} = P_{A1} - R$ = 11.410 dBm – 1.3dB = 10.110 dBm = 10.256 mW
b) $P_{meas} = P_C + G_2$ = -3.490 dBm + 10.5dB = 7.010 dBm = 5.024 mW
c) Outside the passband $P_{out} = P_{A1} - A$ = 11.410 dBm – 19.8dB = -8.390 dBm = 0.145 mW

4. $\Gamma = (Z - Z_0)/(Z + Z_0) = 0.367 + j\cdot(-0.363) = 0.516\angle{-44.687}°$;
b) Complex calculus from L7/L8, 2 solutions for the match, $Z_0 = 50\Omega$ lines
$\theta_{S1} = 82.9°$; $Im(y_S) = -1.204$; $\theta_{p1} = 129.7°$ **and** $\theta_{S2} = 141.8°$; $Im(y_S) = 1.204$; $\theta_{p2} = 50.3°$
c) Obviously the shunt stub θ_p is towards the 50 ohm source

5. In any order we cascade the two devices the gain will be the same $G = G_1 + G_2$ = 9.5dB + 10.5dB = 20.0dB. The "best" placement for the two devices refers to the minimum noise factor.
F_1 = 1.10dB=1.288, F_2 = 0.92dB=1.236, G_1 = 9.5dB = 8.913, G_2 = 10.5dB = 11.220
We compute $F_{12} = F_1 + (F_2-1)/G_1 = 1.315$ and $F_{21} = F_2 + (F_1-1)/G_2 = 1.262$, we obtain a lower noise factor when we first use device 2 in the cascade. The result is F = 1.009dB and G = 20.0dB

6. a) The match for maximum gain is available only if the transistor is unconditionally stable.
$|S_{11}| = 0.621 < 1$; $|S_{22}| = 0.553 < 1$; $K = 1.218 > 1$; $|\Delta| = |(0.248) + j\cdot(-0.041)| = 0.252 < 1$
b) $B_1 = 1.017$; $C_1 = (-0.262) + j\cdot(0.422)$; $\Gamma_S = (-0.427) + j\cdot(-0.687) = 0.809\angle{-121.9}°$
$B_2 = 0.857$; $C_2 = (-0.409) + j\cdot(-0.069)$; $\Gamma_L = (-0.766) + j\cdot(0.128) = 0.776\angle{170.5}°$
c) towards the source: $\theta_{s1} = 132.9°$; $\theta_{p1} = 110.0°$ **or** $\theta_{s2} = 168.9°$; $\theta_{p2} = 70.0°$
toward the load: $\theta_{s1} = 165.2°$; $\theta_{p1} = 112.1°$ **or** $\theta_{s2} = 24.3°$; $\theta_{p2} = 67.9°$

Subject no. 20

1. $Z = 44.00+ j\cdot(-41.19)$; $\Gamma = (Z - Z_0)/(Z + Z_0) = 0.108+ j\cdot(-0.391) = 0.406\angle -74.6°$, plot point in complex plane either with rectangular coordinates or polar coordinates

2. $y = 0.840 + j\cdot0.810$; $Z = Z_0 / (0.840 + j\cdot0.810) = 30.844\Omega + j\cdot(-29.7422)\Omega$

3. a) Pin = 1.60mW = 2.041dBm; Pc = 2.041dBm - 4.40dB = -2.359 dBm = 0.5809mW
Ideal lossless coupler: P_T = 1.60mW – 0.5809mW = 1.0191 mW= 0.082 dBm ; after amplifier G_1 we have $P_{A1} = P_T + G_1$ = 0.082 dBm + 7.7dB = 7.782 dBm ; inside the filter passband maximum attenuation introduced by the filter is equal to the ripple, $P_{out,max} = P_{A1}$ = 7.782 dBm = 6.00mW, $P_{out,min} = P_{A1} - R$ = 7.782 dBm – 2.3dB = 5.482 dBm = 3.534 mW
b) $P_{meas} = P_C + G_2$ = -2.359 dBm + 9.8dB = 7.441 dBm = 5.548 mW
c) Outside the passband $P_{out} = P_{A1} - A$ = 7.782 dBm – 22.0dB = -14.218 dBm = 0.038 mW

4. $\Gamma = (Z - Z_0)/(Z + Z_0) = 0.103 + j\cdot(0.358) = 0.373\angle 73.891°$;
b) Complex calculus from L7/L8, 2 solutions for the match, $Z_0 = 50\Omega$ lines
$\theta_{S1} = 19.0°$; $Im(y_S) = -0.803$; $\theta_{p1} = 141.2°$ **and** $\theta_{S2} = 87.1°$; $Im(y_S) = 0.803$; $\theta_{p2} = 38.8°$
c) Obviously the shunt stub θ_p is towards the 50 ohm source

5. In any order we cascade the two devices the gain will be the same $G = G_1 + G_2$ = 9.4dB + 10.8dB = 20.2dB. The "best" placement for the two devices refers to the minimum noise factor.
F_1 = 1.19dB=1.315, F_2 = 0.90dB=1.230, G_1 = 9.4dB = 8.710, G_2 = 10.8dB = 12.023
We compute $F_{12} = F_1 + (F_2-1)/G_1 = 1.342$ and $F_{21} = F_2 + (F_1-1)/G_2 = 1.256$, we obtain a lower noise factor when we first use device 2 in the cascade. The result is F = 0.992dB and G = 20.2dB

6. a) The match for maximum gain is available only if the transistor is unconditionally stable.
$|S_{11}| = 0.653 < 1$; $|S_{22}| = 0.519 < 1$; $K = 1.090 > 1$; $|\Delta| = |(-0.149)+ j\cdot(0.243)| = 0.285 < 1$
b) $B_1 = 1.076$; $C_1 = (-0.526) + j\cdot(-0.083)$; $\Gamma_S = (-0.856) + j\cdot(0.135) = 0.866\angle 171.0°$
$B_2 = 0.762$; $C_2 = (-0.199) + j\cdot(-0.316)$; $\Gamma_L = (-0.434) + j\cdot(0.690) = 0.815\angle 122.2°$
c) towards the source: $\theta_{s1} = 169.5°$; $\theta_{p1} = 106.1°$ **or** $\theta_{s2} = 19.5°$; $\theta_{p2} = 73.9°$
toward the load: $\theta_{s1} = 11.2°$; $\theta_{p1} = 109.6°$ **or** $\theta_{s2} = 46.6°$; $\theta_{p2} = 70.4°$

Subject no. 21

1. $Z = 38.00 + j\cdot(74.79)$; $\Gamma = (Z - Z_0)/(Z + Z_0) = 0.340 + j\cdot(0.561) = 0.656\angle 58.8°$, plot point in complex plane either with rectangular coordinates or polar coordinates

2. $y = 1.240 + j\cdot 0.825$; $Z = Z_0 / (1.240 + j\cdot 0.825) = 27.950\Omega + j\cdot(-18.5959)\Omega$

3. a) Pin = 2.45mW = 3.892dBm; Pc = 3.892dBm - 5.55dB = -1.658 dBm = 0.6826mW
Ideal lossless coupler: P_T = 2.45mW – 0.6826mW = 1.7674 mW= 2.473 dBm ; after amplifier G_1 we have $P_{A1} = P_T + G_1$ = 2.473 dBm + 8.4dB = 10.873 dBm ; inside the filter passband maximum attenuation introduced by the filter is equal to the ripple, $P_{out,max} = P_{A1}$ = 10.873 dBm = 12.23mW, $P_{out,min} = P_{A1} - R$ = 10.873 dBm – 0.8dB = 10.073 dBm = 10.170 mW
b) $P_{meas} = P_C + G_2$ = -1.658 dBm + 10.8dB = 9.142 dBm = 8.207 mW
c) Outside the passband $P_{out} = P_{A1} - A$ = 10.873 dBm – 24.8dB = -13.927 dBm = 0.040 mW

4. $\Gamma = (Z - Z_0)/(Z + Z_0) = 0.195 + j\cdot(-0.479) = 0.517\angle -67.873°$;
b) Complex calculus from L7/L8, 2 solutions for the match, $Z_0 = 50\Omega$ lines
$\theta_{S1} = 94.5°$; $Im(y_S) = -1.209$; $\theta_{p1} = 129.6°$ **and** $\theta_{S2} = 153.4°$; $Im(y_S) = 1.209$; $\theta_{p2} = 50.4°$
c) Obviously the shunt stub θ_p is towards the 50 ohm source

5. In any order we cascade the two devices the gain will be the same $G = G_1 + G_2$ = 8.4dB + 11.0dB = 19.4dB. The "best" placement for the two devices refers to the minimum noise factor.
F_1 = 1.15dB=1.303, F_2 = 1.02dB=1.265, G_1 = 8.4dB = 6.918, G_2 = 11.0dB = 12.589
We compute $F_{12} = F_1 + (F_2-1)/G_1 = 1.341$ and $F_{21} = F_2 + (F_1-1)/G_2 = 1.289$, we obtain a lower noise factor when we first use device 2 in the cascade. The result is F = 1.102dB and G = 19.4dB

6. a) The match for maximum gain is available only if the transistor is unconditionally stable.
$|S_{11}| = 0.640 < 1$; $|S_{22}| = 0.550 < 1$; $K = 1.184 > 1$; $|\Delta| = |(0.251) + j\cdot(0.130)| = 0.283 < 1$
b) $B_1 = 1.027$; $C_1 = (-0.393) + j\cdot(0.315)$; $\Gamma_S = (-0.642) + j\cdot(-0.515) = 0.824\angle -141.3°$
$B_2 = 0.813$; $C_2 = (-0.367) + j\cdot(-0.145)$; $\Gamma_L = (-0.726) + j\cdot(0.288) = 0.781\angle 158.4°$
c) towards the source: $\theta_{s1} = 143.4°$; $\theta_{p1} = 109.0°$ **or** $\theta_{s2} = 177.9°$; $\theta_{p2} = 71.0°$
toward the load: $\theta_{s1} = 171.5°$; $\theta_{p1} = 111.8°$ **or** $\theta_{s2} = 30.1°$; $\theta_{p2} = 68.2°$

Subject no. 22

1. $Z = 50.00 + j\cdot(-50.55)$; $\Gamma = (Z - Z_0)/(Z + Z_0) = 0.204 + j\cdot(-0.403) = 0.451\angle -63.2°$, plot point in complex plane either with rectangular coordinates or polar coordinates

2. $y = 0.995 - j\cdot 0.700$; $Z = Z_0 / (0.995 - j\cdot 0.700) = 33.614\Omega + j\cdot(23.6482)\Omega$

3. a) Pin = 3.20mW = 5.051dBm; Pc = 5.051dBm - 4.20dB = 0.851 dBm = 1.2166mW
Ideal lossless coupler: P_T = 3.20mW – 1.2166mW = 1.9834 mW= 2.974 dBm ; after amplifier G_1 we have $P_{A1} = P_T + G_1$ = 2.974 dBm + 9.8dB = 12.774 dBm ; inside the filter passband maximum attenuation introduced by the filter is equal to the ripple, $P_{out,max} = P_{A1}$ = 12.774 dBm = 18.94mW, $P_{out,min} = P_{A1} - R$ = 12.774 dBm – 1.6dB = 11.174 dBm = 13.104 mW
b) $P_{meas} = P_C + G_2$ = 0.851 dBm + 8.3dB = 9.151 dBm = 8.225 mW
c) Outside the passband $P_{out} = P_{A1} - A$ = 12.774 dBm – 20.4dB = -7.626 dBm = 0.173 mW

4. $\Gamma = (Z - Z_0)/(Z + Z_0) = 0.223 + j\cdot(0.475) = 0.525\angle 64.827°$;
b) Complex calculus from L7/L8, 2 solutions for the match, $Z_0 = 50\Omega$ lines
$\theta_{S1} = 28.4°$; $Im(y_S) = -1.233$; $\theta_{p1} = 129.0°$ **and** $\theta_{S2} = 86.8°$; $Im(y_S) = 1.233$; $\theta_{p2} = 51.0°$
c) Obviously the shunt stub θ_p is towards the 50 ohm source

5. In any order we cascade the two devices the gain will be the same $G = G_1 + G_2$ = 8.8dB + 11.8dB = 20.6dB. The "best" placement for the two devices refers to the minimum noise factor.
F_1 = 1.12dB=1.294, F_2 = 1.06dB=1.276, G_1 = 8.8dB = 7.586, G_2 = 11.8dB = 15.136
We compute $F_{12} = F_1 + (F_2 - 1)/G_1 = 1.331$ and $F_{21} = F_2 + (F_1 - 1)/G_2 = 1.296$, we obtain a lower noise factor when we first use device 2 in the cascade. The result is F = 1.126dB and G = 20.6dB

6. a) The match for maximum gain is available only if the transistor is unconditionally stable.
$|S_{11}| = 0.656 < 1$; $|S_{22}| = 0.518 < 1$; $K = 1.082 > 1$; $|\Delta| = |(-0.166) + j\cdot(0.237)| = 0.289 < 1$
b) $B_1 = 1.078$; $C_1 = (-0.526) + j\cdot(-0.094)$; $\Gamma_S = (-0.858) + j\cdot(0.154) = 0.872\angle 169.9°$
$B_2 = 0.754$; $C_2 = (-0.189) + j\cdot(-0.318)$; $\Gamma_L = (-0.420) + j\cdot(0.705) = 0.821\angle 120.8°$
c) towards the source: $\theta_{s1} = 170.4°$; $\theta_{p1} = 105.7°$ **or** $\theta_{s2} = 19.7°$; $\theta_{p2} = 74.3°$
toward the load: $\theta_{s1} = 12.2°$; $\theta_{p1} = 109.2°$ **or** $\theta_{s2} = 47.0°$; $\theta_{p2} = 70.8°$

Subject no. 23

1. $Z = 31.32 + j\cdot(22.86)$; $\Gamma = (Z - Z_0)/(Z + Z_0) = -0.140 + j\cdot(0.320) = 0.350\angle 113.6°$, plot point in complex plane either with rectangular coordinates or polar coordinates

2. $y = 0.745 + j\cdot 0.855$; $Z = Z_0 / (0.745 + j\cdot 0.855) = 28.965\Omega + j\cdot(-33.2413)\Omega$

3. a) Pin = 2.20mW = 3.424dBm; Pc = 3.424dBm - 6.95dB = -3.526 dBm = 0.4440mW
Ideal lossless coupler: P_T = 2.20mW – 0.4440mW = 1.7560 mW= 2.445 dBm ; after amplifier G_1 we have $P_{A1} = P_T + G_1$ = 2.445 dBm + 6.0dB = 8.445 dBm ; inside the filter passband maximum attenuation introduced by the filter is equal to the ripple, $P_{out,max} = P_{A1}$ = 8.445 dBm = 6.99mW, $P_{out,min} = P_{A1} - R$ = 8.445 dBm – 0.8dB = 7.645 dBm = 5.815 mW
b) $P_{meas} = P_C + G_2$ = -3.526 dBm + 8.7dB = 5.174 dBm = 3.292 mW
c) Outside the passband $P_{out} = P_{A1} - A$ = 8.445 dBm – 24.2dB = -15.755 dBm = 0.027 mW

4. $\Gamma = (Z - Z_0)/(Z + Z_0) = 0.229 + j\cdot(0.449) = 0.504\angle 63.020°$;
b) Complex calculus from L7/L8, 2 solutions for the match, $Z_0 = 50\Omega$ lines
$\theta_{S1} = 28.6°$; $Im(y_S) = -1.168$; $\theta_{p1} = 130.6°$ **and** $\theta_{S2} = 88.3°$; $Im(y_S) = 1.168$; $\theta_{p2} = 49.4°$
c) Obviously the shunt stub θ_p is towards the 50 ohm source

5. In any order we cascade the two devices the gain will be the same $G = G_1 + G_2$ = 9.0dB + 10.2dB = 19.2dB. The "best" placement for the two devices refers to the minimum noise factor.
F_1 = 1.27dB=1.340, F_2 = 1.02dB=1.265, G_1 = 9.0dB = 7.943, G_2 = 10.2dB = 10.471
We compute $F_{12} = F_1 + (F_2-1)/G_1 = 1.373$ and $F_{21} = F_2 + (F_1-1)/G_2 = 1.297$, we obtain a lower noise factor when we first use device 2 in the cascade. The result is F = 1.130dB and G = 19.2dB

6. a) The match for maximum gain is available only if the transistor is unconditionally stable.
$|S_{11}| = 0.623 < 1$; $|S_{22}| = 0.520 < 1$; $K = 1.112 > 1$; $|\Delta| = |(-0.100) + j\cdot(0.262)| = 0.281 < 1$
b) $B_1 = 1.039$; $C_1 = (-0.509) + j\cdot(0.047)$; $\Gamma_S = (-0.833) + j\cdot(-0.076) = 0.836\angle -174.8°$
$B_2 = 0.804$; $C_2 = (-0.219) + j\cdot(-0.324)$; $\Gamma_L = (-0.443) + j\cdot(0.656) = 0.792\angle 124.0°$
c) towards the source: $\theta_{s1} = 160.8°$; $\theta_{p1} = 108.2°$ **or** $\theta_{s2} = 14.0°$; $\theta_{p2} = 71.8°$
toward the load: $\theta_{s1} = 9.2°$; $\theta_{p1} = 111.1°$ **or** $\theta_{s2} = 46.8°$; $\theta_{p2} = 68.9°$

Subject no. 24

1. $Z = 16.58 + j\cdot(-23.89)$; $\Gamma = (Z - Z_0)/(Z + Z_0) = -0.331 + j\cdot(-0.477) = 0.581\angle{-124.7°}$, plot point in complex plane either with rectangular coordinates or polar coordinates

2. $y = 0.805 + j\cdot 0.845$; $Z = Z_0 / (0.805 + j\cdot 0.845) = 29.551\Omega + j\cdot(-31.0194)\Omega$

3. a) Pin = 3.60mW = 5.563dBm; Pc = 5.563dBm - 6.45dB = -0.887 dBm = 0.8153mW
Ideal lossless coupler: P_T = 3.60mW – 0.8153mW = 2.7847 mW= 4.448 dBm ; after amplifier G_1 we have $P_{A1} = P_T + G_1$ = 4.448 dBm + 7.4dB = 11.848 dBm ; inside the filter passband maximum attenuation introduced by the filter is equal to the ripple, $P_{out,max} = P_{A1}$ = 11.848 dBm = 15.30mW, $P_{out,min} = P_{A1} - R$ = 11.848 dBm – 2.9dB = 8.948 dBm = 7.848 mW
b) $P_{meas} = P_C + G_2$ = -0.887 dBm + 9.4dB = 8.513 dBm = 7.101 mW
c) Outside the passband $P_{out} = P_{A1} - A$ = 11.848 dBm – 17.1dB = -5.252 dBm = 0.298 mW

4. $\Gamma = (Z - Z_0)/(Z + Z_0) = 0.261 + j\cdot(-0.394) = 0.473\angle{-56.523°}$;
b) Complex calculus from L7/L8, 2 solutions for the match, $Z_0 = 50\Omega$ lines
$\theta_{S1} = 87.4°$; $Im(y_S) = -1.074$; $\theta_{p1} = 133.0°$ **and** $\theta_{S2} = 149.1°$; $Im(y_S) = 1.074$; $\theta_{p2} = 47.0°$
c) Obviously the shunt stub θ_p is towards the 50 ohm source

5. In any order we cascade the two devices the gain will be the same $G = G_1 + G_2$ = 9.1dB + 10.0dB = 19.1dB. The "best" placement for the two devices refers to the minimum noise factor.
F_1 = 1.29dB=1.346, F_2 = 0.97dB=1.250, G_1 = 9.1dB = 8.128, G_2 = 10.0dB = 10.000
We compute $F_{12} = F_1 + (F_2-1)/G_1 = 1.377$ and $F_{21} = F_2 + (F_1-1)/G_2 = 1.285$, we obtain a lower noise factor when we first use device 2 in the cascade. The result is F = 1.089dB and G = 19.1dB

6. a) The match for maximum gain is available only if the transistor is unconditionally stable.
$|S_{11}| = 0.618 < 1$; $|S_{22}| = 0.554 < 1$; $K = 1.214 > 1$; $|\Delta| = |(0.246) + j\cdot(-0.048)| = 0.250 < 1$
b) $B_1 = 1.012$; $C_1 = (-0.252) + j\cdot(0.426)$; $\Gamma_S = (-0.411) + j\cdot(-0.696) = 0.808\angle{-120.6°}$
$B_2 = 0.862$; $C_2 = (-0.413) + j\cdot(-0.063)$; $\Gamma_L = (-0.769) + j\cdot(0.117) = 0.778\angle{171.4°}$
c) towards the source: $\theta_{s1} = 132.3°$; $\theta_{p1} = 110.0°$ **or** $\theta_{s2} = 168.3°$; $\theta_{p2} = 70.0°$
toward the load: $\theta_{s1} = 164.9°$; $\theta_{p1} = 112.0°$ **or** $\theta_{s2} = 23.8°$; $\theta_{p2} = 68.0°$

Subject no. 25

1. $Z = 59.00 + j\cdot(-30.81)$; $\Gamma = (Z - Z_0)/(Z + Z_0) = 0.150 + j\cdot(-0.240) = 0.283\angle{-57.9°}$, plot point in complex plane either with rectangular coordinates or polar coordinates

2. $y = 1.135 - j\cdot0.775$; $Z = Z_0 / (1.135 - j\cdot0.775) = 30.045\Omega + j\cdot(20.5151)\Omega$

3. a) Pin = 2.45mW = 3.892dBm; Pc = 3.892dBm - 5.85dB = -1.958 dBm = 0.6370mW
Ideal lossless coupler: P_T = 2.45mW – 0.6370mW = 1.8130 mW= 2.584 dBm ; after amplifier G_1 we have $P_{A1} = P_T + G_1$ = 2.584 dBm + 7.0dB = 9.584 dBm ; inside the filter passband maximum attenuation introduced by the filter is equal to the ripple, $P_{out,max} = P_{A1}$ = 9.584 dBm = 9.09mW, $P_{out,min} = P_{A1} - R$ = 9.584 dBm – 1.0dB = 8.584 dBm = 7.218 mW
b) $P_{meas} = P_C + G_2$ = -1.958 dBm + 10.3dB = 8.342 dBm = 6.826 mW
c) Outside the passband $P_{out} = P_{A1} - A$ = 9.584 dBm – 20.5dB = -10.916 dBm = 0.081 mW

4. $\Gamma = (Z - Z_0)/(Z + Z_0) = 0.012 + j\cdot(0.506) = 0.506\angle 88.589°$;
b) Complex calculus from L7/L8, 2 solutions for the match, $Z_0 = 50\Omega$ lines
$\theta_{S1} = 15.9°$; $Im(y_S) = -1.174$; $\theta_{p1} = 130.4°$ **and** $\theta_{S2} = 75.5°$; $Im(y_S) = 1.174$; $\theta_{p2} = 49.6°$
c) Obviously the shunt stub θ_p is towards the 50 ohm source

5. In any order we cascade the two devices the gain will be the same $G = G_1 + G_2$ = 9.5dB + 11.5dB = 21.0dB. The "best" placement for the two devices refers to the minimum noise factor.
F_1 = 1.12dB=1.294, F_2 = 0.93dB=1.239, G_1 = 9.5dB = 8.913, G_2 = 11.5dB = 14.125
We compute $F_{12} = F_1 + (F_2-1)/G_1 = 1.321$ and $F_{21} = F_2 + (F_1-1)/G_2 = 1.260$, we obtain a lower noise factor when we first use device 2 in the cascade. The result is F = 1.002dB and G = 21.0dB

6. a) The match for maximum gain is available only if the transistor is unconditionally stable.
$|S_{11}| = 0.641 < 1$; $|S_{22}| = 0.520 < 1$; $K = 1.102 > 1$; $|\Delta| = |(-0.122) + j\cdot(0.252)| = 0.280 < 1$
b) $B_1 = 1.062$; $C_1 = (-0.523) + j\cdot(-0.032)$; $\Gamma_S = (-0.852) + j\cdot(0.052) = 0.853\angle 176.5°$
$B_2 = 0.781$; $C_2 = (-0.212) + j\cdot(-0.317)$; $\Gamma_L = (-0.447) + j\cdot(0.669) = 0.805\angle 123.7°$
c) towards the source: $\theta_{s1} = 166.0°$; $\theta_{p1} = 107.0°$ **or** $\theta_{s2} = 17.4°$; $\theta_{p2} = 73.0°$
toward the load: $\theta_{s1} = 9.9°$; $\theta_{p1} = 110.2°$ **or** $\theta_{s2} = 46.3°$; $\theta_{p2} = 69.8°$

Subject no. 26

1. $Z = 20.55 + j\cdot(-24.60)$; $\Gamma = (Z - Z_0)/(Z + Z_0) = -0.264 + j\cdot(-0.441) = 0.514\angle -120.9°$, plot point in complex plane either with rectangular coordinates or polar coordinates

2. $y = 1.265 + j\cdot 1.155$; $Z = Z_0 / (1.265 + j\cdot 1.155) = 21.556\Omega + j\cdot(-19.6813)\Omega$

3. a) Pin = 1.90mW = 2.788dBm; Pc = 2.788dBm - 4.80dB = -2.012 dBm = 0.6291mW
Ideal lossless coupler: P_T = 1.90mW – 0.6291mW = 1.2709 mW= 1.041 dBm ; after amplifier G_1 we have $P_{A1} = P_T + G_1$ = 1.041 dBm + 6.4dB = 7.441 dBm ; inside the filter passband maximum attenuation introduced by the filter is equal to the ripple, $P_{out,max} = P_{A1}$ = 7.441 dBm = 5.55mW, $P_{out,min} = P_{A1} - R$ = 7.441 dBm – 0.9dB = 6.541 dBm = 4.509 mW
b) $P_{meas} = P_C + G_2$ = -2.012 dBm + 9.3dB = 7.288 dBm = 5.355 mW
c) Outside the passband $P_{out} = P_{A1} - A$ = 7.441 dBm – 16.1dB = -8.659 dBm = 0.136 mW

4. $\Gamma = (Z - Z_0)/(Z + Z_0) = 0.282 + j\cdot(-0.419) = 0.505\angle -56.030°$;
b) Complex calculus from L7/L8, 2 solutions for the match, $Z_0 = 50\Omega$ lines
$\theta_{S1} = 88.2°$; $Im(y_S) = -1.172$; $\theta_{p1} = 130.5°$ **and** $\theta_{S2} = 147.8°$; $Im(y_S) = 1.172$; $\theta_{p2} = 49.5°$
c) Obviously the shunt stub θ_p is towards the 50 ohm source

5. In any order we cascade the two devices the gain will be the same $G = G_1 + G_2$ = 8.8dB + 11.6dB = 20.4dB. The "best" placement for the two devices refers to the minimum noise factor.
F_1 = 1.25dB=1.334, F_2 = 0.91dB=1.233, G_1 = 8.8dB = 7.586, G_2 = 11.6dB = 14.454
We compute $F_{12} = F_1 + (F_2-1)/G_1 = 1.364$ and $F_{21} = F_2 + (F_1-1)/G_2 = 1.256$, we obtain a lower noise factor when we first use device 2 in the cascade. The result is F = 0.991dB and G = 20.4dB

6. a) The match for maximum gain is available only if the transistor is unconditionally stable.
$|S_{11}| = 0.629 < 1$; $|S_{22}| = 0.520 < 1$; $K = 1.108 > 1$; $|\Delta| = |(-0.107) + j\cdot(0.259)| = 0.280 < 1$
b) $B_1 = 1.047$; $C_1 = (-0.515) + j\cdot(0.021)$; $\Gamma_S = (-0.842) + j\cdot(-0.034) = 0.842\angle -177.7°$
$B_2 = 0.796$; $C_2 = (-0.217) + j\cdot(-0.322)$; $\Gamma_L = (-0.445) + j\cdot(0.661) = 0.797\angle 124.0°$
c) towards the source: $\theta_{s1} = 162.5°$; $\theta_{p1} = 107.7°$ **or** $\theta_{s2} = 15.1°$; $\theta_{p2} = 72.3°$
toward the load: $\theta_{s1} = 9.4°$; $\theta_{p1} = 110.8°$ **or** $\theta_{s2} = 46.6°$; $\theta_{p2} = 69.2°$

Subject no. 27

1. $Z = 74.00 + j\cdot(64.31)$; $\Gamma = (Z - Z_0)/(Z + Z_0) = 0.364 + j\cdot(0.330) = 0.491\angle 42.1°$, plot point in complex plane either with rectangular coordinates or polar coordinates

2. $y = 1.085 + j\cdot 0.860$; $Z = Z_0 / (1.085 + j\cdot 0.860) = 28.302\Omega + j\cdot(-22.4329)\Omega$

3. a) Pin = 1.80mW = 2.553dBm; Pc = 2.553dBm - 5.55dB = -2.997 dBm = 0.5015mW
Ideal lossless coupler: P_T = 1.80mW – 0.5015mW = 1.2985 mW= 1.134 dBm ; after amplifier G_1 we have $P_{A1} = P_T + G_1$ = 1.134 dBm + 9.5dB = 10.634 dBm ; inside the filter passband maximum attenuation introduced by the filter is equal to the ripple, $P_{out,max} = P_{A1}$ = 10.634 dBm = 11.57mW, $P_{out,min} = P_{A1} - R$ = 10.634 dBm – 1.9dB = 8.734 dBm = 7.472 mW
b) $P_{meas} = P_C + G_2$ = -2.997 dBm + 9.7dB = 6.703 dBm = 4.680 mW
c) Outside the passband $P_{out} = P_{A1} - A$ = 10.634 dBm – 17.0dB = -6.366 dBm = 0.231 mW

4. $\Gamma = (Z - Z_0)/(Z + Z_0) = 0.052 + j\cdot(0.309) = 0.314\angle 80.520°$;
b) Complex calculus from L7/L8, 2 solutions for the match, $Z_0 = 50\Omega$ lines
$\theta_{S1} = 13.9°$; $Im(y_S) = -0.661$; $\theta_{p1} = 146.5°$ **and** $\theta_{S2} = 85.6°$; $Im(y_S) = 0.661$; $\theta_{p2} = 33.5°$
c) Obviously the shunt stub θ_p is towards the 50 ohm source

5. In any order we cascade the two devices the gain will be the same $G = G_1 + G_2$ = 8.0dB + 11.6dB = 19.6dB. The "best" placement for the two devices refers to the minimum noise factor.
F_1 = 1.26dB=1.337, F_2 = 1.05dB=1.274, G_1 = 8.0dB = 6.310, G_2 = 11.6dB = 14.454
We compute $F_{12} = F_1 + (F_2-1)/G_1 = 1.380$ and $F_{21} = F_2 + (F_1-1)/G_2 = 1.297$, we obtain a lower noise factor when we first use device 2 in the cascade. The result is F = 1.129dB and G = 19.6dB

6. a) The match for maximum gain is available only if the transistor is unconditionally stable.
$|S_{11}| = 0.665 < 1$; $|S_{22}| = 0.515 < 1$; $K = 1.059 > 1$; $|\Delta| = |(-0.214) + j\cdot(0.215)| = 0.303 < 1$
b) $B_1 = 1.085$; $C_1 = (-0.524) + j\cdot(-0.128)$; $\Gamma_S = (-0.864) + j\cdot(0.211) = 0.890\angle 166.3°$
$B_2 = 0.731$; $C_2 = (-0.162) + j\cdot(-0.322)$; $\Gamma_L = (-0.378) + j\cdot(0.750) = 0.840\angle 116.7°$
c) towards the source: $\theta_{s1} = 173.3°$; $\theta_{p1} = 104.4°$ **or** $\theta_{s2} = 20.4°$; $\theta_{p2} = 75.6°$
toward the load: $\theta_{s1} = 15.2°$; $\theta_{p1} = 107.9°$ **or** $\theta_{s2} = 48.1°$; $\theta_{p2} = 72.1°$

Subject no. 28

1. $Z = 34.18 + j\cdot(-23.25)$; $\Gamma = (Z - Z_0)/(Z + Z_0) = -0.104 + j\cdot(-0.305) = 0.322\angle -108.8°$, plot point in complex plane either with rectangular coordinates or polar coordinates

2. $y = 0.715 - j\cdot 0.940$; $Z = Z_0 / (0.715 - j\cdot 0.940) = 25.630\Omega + j\cdot(33.6960)\Omega$

3. a) Pin = 2.30mW = 3.617dBm; Pc = 3.617dBm - 4.30dB = -0.683 dBm = 0.8545mW
Ideal lossless coupler: P_T = 2.30mW – 0.8545mW = 1.4455 mW= 1.600 dBm ; after amplifier G_1 we have $P_{A1} = P_T + G_1$ = 1.600 dBm + 8.1dB = 9.700 dBm ; inside the filter passband maximum attenuation introduced by the filter is equal to the ripple, $P_{out,max} = P_{A1}$ = 9.700 dBm = 9.33mW, $P_{out,min} = P_{A1} - R$ = 9.700 dBm – 1.0dB = 8.700 dBm = 7.413 mW
b) $P_{meas} = P_C + G_2$ = -0.683 dBm + 8.2dB = 7.517 dBm = 5.646 mW
c) Outside the passband $P_{out} = P_{A1} - A$ = 9.700 dBm – 23.9dB = -14.200 dBm = 0.038 mW

4. $\Gamma = (Z - Z_0)/(Z + Z_0) = 0.353 + j\cdot(-0.378) = 0.518\angle -46.961°$;
b) Complex calculus from L7/L8, 2 solutions for the match, $Z_0 = 50\Omega$ lines
$\theta_{S1} = 84.1°$; $Im(y_S) = -1.210$; $\theta_{p1} = 129.6°$ **and** $\theta_{S2} = 142.9°$; $Im(y_S) = 1.210$; $\theta_{p2} = 50.4°$
c) Obviously the shunt stub θ_p is towards the 50 ohm source

5. In any order we cascade the two devices the gain will be the same $G = G_1 + G_2$ = 8.8dB + 11.0dB = 19.8dB. The "best" placement for the two devices refers to the minimum noise factor.
F_1 = 1.24dB=1.330, F_2 = 1.04dB=1.271, G_1 = 8.8dB = 7.586, G_2 = 11.0dB = 12.589
We compute $F_{12} = F_1 + (F_2-1)/G_1 = 1.366$ and $F_{21} = F_2 + (F_1-1)/G_2 = 1.297$, we obtain a lower noise factor when we first use device 2 in the cascade. The result is F = 1.129dB and G = 19.8dB

6. a) The match for maximum gain is available only if the transistor is unconditionally stable.
$|S_{11}| = 0.626 < 1$; $|S_{22}| = 0.520 < 1$; $K = 1.110 > 1$; $|\Delta| = |(-0.103) + j\cdot(0.261)| = 0.280 < 1$
b) $B_1 = 1.043$; $C_1 = (-0.512) + j\cdot(0.034)$; $\Gamma_S = (-0.837) + j\cdot(-0.055) = 0.839\angle -176.2°$
$B_2 = 0.800$; $C_2 = (-0.218) + j\cdot(-0.323)$; $\Gamma_L = (-0.444) + j\cdot(0.659) = 0.795\angle 124.0°$
c) towards the source: $\theta_{s1} = 161.6°$; $\theta_{p1} = 107.9°$ **or** $\theta_{s2} = 14.6°$; $\theta_{p2} = 72.1°$
toward the load: $\theta_{s1} = 9.3°$; $\theta_{p1} = 110.9°$ **or** $\theta_{s2} = 46.7°$; $\theta_{p2} = 69.1°$

Subject no. 29

1. $Z = 29.27 + j\cdot(19.30)$; $\Gamma = (Z - Z_0)/(Z + Z_0) = -0.191 + j\cdot(0.290) = 0.347\angle 123.4°$, plot point in complex plane either with rectangular coordinates or polar coordinates

2. $y = 0.985 - j\cdot 0.815$; $Z = Z_0 / (0.985 - j\cdot 0.815) = 30.132\Omega + j\cdot(24.9319)\Omega$

3. a) Pin = 2.55mW = 4.065dBm; Pc = 4.065dBm - 5.05dB = -0.985 dBm = 0.7972mW
Ideal lossless coupler: P_T = 2.55mW – 0.7972mW = 1.7528 mW= 2.437 dBm ; after amplifier G_1 we have $P_{A1} = P_T + G_1$ = 2.437 dBm + 7.4dB = 9.837 dBm ; inside the filter passband maximum attenuation introduced by the filter is equal to the ripple, $P_{out,max} = P_{A1}$ = 9.837 dBm = 9.63mW, $P_{out,min} = P_{A1} - R$ = 9.837 dBm – 2.8dB = 7.037 dBm = 5.055 mW
b) $P_{meas} = P_C + G_2$ = -0.985 dBm + 8.1dB = 7.115 dBm = 5.147 mW
c) Outside the passband $P_{out} = P_{A1} - A$ = 9.837 dBm – 17.4dB = -7.563 dBm = 0.175 mW

4. $\Gamma = (Z - Z_0)/(Z + Z_0) = 0.104 + j\cdot(-0.365) = 0.380\angle -74.120°$;
b) Complex calculus from L7/L8, 2 solutions for the match, $Z_0 = 50\Omega$ lines
$\theta_{S1} = 93.2°$; $Im(y_S) = -0.821$; $\theta_{p1} = 140.6°$ **and** $\theta_{S2} = 160.9°$; $Im(y_S) = 0.821$; $\theta_{p2} = 39.4°$
c) Obviously the shunt stub θ_p is towards the 50 ohm source

5. In any order we cascade the two devices the gain will be the same $G = G_1 + G_2$ = 8.8dB + 11.1dB = 19.9dB. The "best" placement for the two devices refers to the minimum noise factor.
F_1 = 1.24dB=1.330, F_2 = 1.08dB=1.282, G_1 = 8.8dB = 7.586, G_2 = 11.1dB = 12.882
We compute $F_{12} = F_1 + (F_2-1)/G_1 = 1.368$ and $F_{21} = F_2 + (F_1-1)/G_2 = 1.308$, we obtain a lower noise factor when we first use device 2 in the cascade. The result is F = 1.166dB and G = 19.9dB

6. a) The match for maximum gain is available only if the transistor is unconditionally stable.
$|S_{11}| = 0.617 < 1$; $|S_{22}| = 0.520 < 1$; $K = 1.125 > 1$; $|\Delta| = |(-0.084) + j\cdot(0.264)| = 0.277 < 1$
b) $B_1 = 1.033$; $C_1 = (-0.502) + j\cdot(0.072)$; $\Gamma_S = (-0.818) + j\cdot(-0.117) = 0.826\angle -171.9°$
$B_2 = 0.813$; $C_2 = (-0.224) + j\cdot(-0.324)$; $\Gamma_L = (-0.445) + j\cdot(0.644) = 0.783\angle 124.7°$
c) towards the source: $\theta_{s1} = 158.8°$; $\theta_{p1} = 108.8°$ **or** $\theta_{s2} = 13.1°$; $\theta_{p2} = 71.2°$
toward the load: $\theta_{s1} = 8.4°$; $\theta_{p1} = 111.7°$ **or** $\theta_{s2} = 46.9°$; $\theta_{p2} = 68.3°$

Subject no. 30

1. $Z = 33.91 + j\cdot(-27.98)$; $\Gamma = (Z - Z_0)/(Z + Z_0) = -0.072 + j\cdot(-0.358) = 0.365\angle -101.5°$, plot point in complex plane either with rectangular coordinates or polar coordinates

2. $y = 0.900 + j\cdot 0.990$; $Z = Z_0 / (0.900 + j\cdot 0.990) = 25.138\Omega + j\cdot(-27.6521)\Omega$

3. a) Pin = 2.80mW = 4.472dBm; Pc = 4.472dBm - 4.65dB = -0.178 dBm = 0.9597mW
Ideal lossless coupler: P_T = 2.80mW – 0.9597mW = 1.8403 mW= 2.649 dBm ; after amplifier G_1 we have $P_{A1} = P_T + G_1$ = 2.649 dBm + 7.3dB = 9.949 dBm ; inside the filter passband maximum attenuation introduced by the filter is equal to the ripple, $P_{out,max} = P_{A1}$ = 9.949 dBm = 9.88mW, $P_{out,min} = P_{A1} - R$ = 9.949 dBm – 1.6dB = 8.349 dBm = 6.837 mW
b) $P_{meas} = P_C + G_2$ = -0.178 dBm + 10.5dB = 10.322 dBm = 10.769 mW
c) Outside the passband $P_{out} = P_{A1} - A$ = 9.949 dBm – 21.7dB = -11.751 dBm = 0.067 mW

4. $\Gamma = (Z - Z_0)/(Z + Z_0) = 0.226 + j\cdot(-0.264) = 0.348\angle -49.474°$;
b) Complex calculus from L7/L8, 2 solutions for the match, $Z_0 = 50\Omega$ lines
$\theta_{S1} = 79.9°$; $Im(y_S) = -0.742$; $\theta_{p1} = 143.4°$ **and** $\theta_{S2} = 149.6°$; $Im(y_S) = 0.742$; $\theta_{p2} = 36.6°$
c) Obviously the shunt stub θ_p is towards the 50 ohm source

5. In any order we cascade the two devices the gain will be the same $G = G_1 + G_2$ = 9.8dB + 11.0dB = 20.8dB. The "best" placement for the two devices refers to the minimum noise factor.
F_1 = 1.11dB=1.291, F_2 = 0.90dB=1.230, G_1 = 9.8dB = 9.550, G_2 = 11.0dB = 12.589
We compute $F_{12} = F_1 + (F_2-1)/G_1 = 1.315$ and $F_{21} = F_2 + (F_1-1)/G_2 = 1.253$, we obtain a lower noise factor when we first use device 2 in the cascade. The result is F = 0.981dB and G = 20.8dB

6. a) The match for maximum gain is available only if the transistor is unconditionally stable.
$|S_{11}| = 0.640 < 1$; $|S_{22}| = 0.550 < 1$; $K = 1.187 > 1$; $|\Delta| = |(0.259) + j\cdot(0.107)| = 0.280 < 1$
b) $B_1 = 1.028$; $C_1 = (-0.380) + j\cdot(0.332)$; $\Gamma_S = (-0.620) + j\cdot(-0.542) = 0.823\angle -138.8°$
$B_2 = 0.814$; $C_2 = (-0.371) + j\cdot(-0.134)$; $\Gamma_L = (-0.734) + j\cdot(0.265) = 0.781\angle 160.1°$
c) towards the source: $\theta_{s1} = 142.1°$; $\theta_{p1} = 109.0°$ **or** $\theta_{s2} = 176.7°$; $\theta_{p2} = 71.0°$
toward the load: $\theta_{s1} = 170.6°$; $\theta_{p1} = 111.8°$ **or** $\theta_{s2} = 29.3°$; $\theta_{p2} = 68.2°$

Subject no. 31

1. $Z = 35.65+ j\cdot(29.46)$; $\Gamma = (Z - Z_0)/(Z + Z_0) = -0.044+ j\cdot(0.359) = 0.362\angle 97.0°$, plot point in complex plane either with rectangular coordinates or polar coordinates

2. $y = 0.870 - j\cdot 0.775$; $Z = Z_0 / (0.870 - j\cdot 0.775) = 32.044\Omega + j\cdot(28.5446)\Omega$

3. a) Pin = 3.85mW = 5.855dBm; Pc = 5.855dBm - 5.90dB = -0.045 dBm = 0.9896mW
Ideal lossless coupler: P_T = 3.85mW – 0.9896mW = 2.8604 mW= 4.564 dBm ; after amplifier G_1 we have $P_{A1} = P_T + G_1$ = 4.564 dBm + 6.3dB = 10.864 dBm ; inside the filter passband maximum attenuation introduced by the filter is equal to the ripple, $P_{out,max} = P_{A1}$ = 10.864 dBm = 12.20mW, $P_{out,min} = P_{A1} - R$ = 10.864 dBm – 2.5dB = 8.364 dBm = 6.862 mW
b) $P_{meas} = P_C + G_2$ = -0.045 dBm + 8.6dB = 8.555 dBm = 7.169 mW
c) Outside the passband $P_{out} = P_{A1} - A$ = 10.864 dBm – 15.9dB = -5.036 dBm = 0.314 mW

4. $\Gamma = (Z - Z_0)/(Z + Z_0) = 0.253 + j\cdot(0.565) = 0.619\angle 65.858°$;
b) Complex calculus from L7/L8, 2 solutions for the match, $Z_0 = 50\Omega$ lines
$\theta_{S1} = 31.2°$; $Im(y_S) = -1.575$; $\theta_{p1} = 122.4°$ **and** $\theta_{S2} = 83.0°$; $Im(y_S) = 1.575$; $\theta_{p2} = 57.6°$
c) Obviously the shunt stub θ_p is towards the 50 ohm source

5. In any order we cascade the two devices the gain will be the same $G = G_1 + G_2$ = 9.7dB + 10.4dB = 20.1dB. The "best" placement for the two devices refers to the minimum noise factor.
F_1 = 1.22dB=1.324, F_2 = 0.90dB=1.230, G_1 = 9.7dB = 9.333, G_2 = 10.4dB = 10.965
We compute $F_{12} = F_1 + (F_2-1)/G_1 = 1.349$ and $F_{21} = F_2 + (F_1-1)/G_2 = 1.260$, we obtain a lower noise factor when we first use device 2 in the cascade. The result is F = 1.003dB and G = 20.1dB

6. a) The match for maximum gain is available only if the transistor is unconditionally stable.
$|S_{11}| = 0.635 < 1$; $|S_{22}| = 0.520 < 1$; $K = 1.105 > 1$; $|\Delta| = |(-0.115)+ j\cdot(0.256)| = 0.280 < 1$
b) $B_1 = 1.054$; $C_1 = (-0.520) + j\cdot(-0.005)$; $\Gamma_S = (-0.848) + j\cdot(0.008) = 0.848\angle 179.4°$
$B_2 = 0.789$; $C_2 = (-0.214) + j\cdot(-0.320)$; $\Gamma_L = (-0.446) + j\cdot(0.665) = 0.801\angle 123.9°$
c) towards the source: $\theta_{s1} = 164.3°$; $\theta_{p1} = 107.3°$ **or** $\theta_{s2} = 16.3°$; $\theta_{p2} = 72.7°$
toward the load: $\theta_{s1} = 9.7°$; $\theta_{p1} = 110.5°$ **or** $\theta_{s2} = 46.5°$; $\theta_{p2} = 69.5°$

Subject no. 32

1. $Z = 40.00 + j\cdot(29.90)$; $\Gamma = (Z - Z_0)/(Z + Z_0) = -0.001 + j\cdot(0.332) = 0.332\angle 90.1°$, plot point in complex plane either with rectangular coordinates or polar coordinates

2. $y = 0.700 + j\cdot 0.790$; $Z = Z_0 / (0.700 + j\cdot 0.790) = 31.415\Omega + j\cdot(-35.4546)\Omega$

3. a) Pin = 2.40mW = 3.802dBm; Pc = 3.802dBm - 4.05dB = -0.248 dBm = 0.9445mW
Ideal lossless coupler: P_T = 2.40mW – 0.9445mW = 1.4555 mW= 1.630 dBm ; after amplifier G_1 we have $P_{A1} = P_T + G_1$ = 1.630 dBm + 9.2dB = 10.830 dBm ; inside the filter passband maximum attenuation introduced by the filter is equal to the ripple, $P_{out,max} = P_{A1}$ = 10.830 dBm = 12.11mW, $P_{out,min} = P_{A1} - R$ = 10.830 dBm – 2.5dB = 8.330 dBm = 6.808 mW
b) $P_{meas} = P_C + G_2$ = -0.248 dBm + 10.4dB = 10.152 dBm = 10.356 mW
c) Outside the passband $P_{out} = P_{A1} - A$ = 10.830 dBm – 22.1dB = -11.270 dBm = 0.075 mW

4. $\Gamma = (Z - Z_0)/(Z + Z_0) = 0.250 + j\cdot(0.487) = 0.547\angle 62.819°$;
b) Complex calculus from L7/L8, 2 solutions for the match, $Z_0 = 50\Omega$ lines
$\theta_{S1} = 30.2°$; $Im(y_S) = -1.308$; $\theta_{p1} = 127.4°$ **and** $\theta_{S2} = 87.0°$; $Im(y_S) = 1.308$; $\theta_{p2} = 52.6°$
c) Obviously the shunt stub θ_p is towards the 50 ohm source

5. In any order we cascade the two devices the gain will be the same $G = G_1 + G_2$ = 9.8dB + 10.5dB = 20.3dB. The "best" placement for the two devices refers to the minimum noise factor.
F_1 = 1.14dB=1.300, F_2 = 1.05dB=1.274, G_1 = 9.8dB = 9.550, G_2 = 10.5dB = 11.220
We compute $F_{12} = F_1 + (F_2-1)/G_1 = 1.329$ and $F_{21} = F_2 + (F_1-1)/G_2 = 1.300$, we obtain a lower noise factor when we first use device 2 in the cascade. The result is F = 1.140dB and G = 20.3dB

6. a) The match for maximum gain is available only if the transistor is unconditionally stable.
$|S_{11}| = 0.636 < 1$; $|S_{22}| = 0.550 < 1$; $K = 1.205 > 1$; $|\Delta| = |(0.265) + j\cdot(0.049)| = 0.270 < 1$
b) $B_1 = 1.029$; $C_1 = (-0.343) + j\cdot(0.370)$; $\Gamma_S = (-0.557) + j\cdot(-0.599) = 0.818\angle -132.9°$
$B_2 = 0.825$; $C_2 = (-0.384) + j\cdot(-0.112)$; $\Gamma_L = (-0.746) + j\cdot(0.218) = 0.777\angle 163.7°$
c) towards the source: $\theta_{s1} = 138.9°$; $\theta_{p1} = 109.4°$ **or** $\theta_{s2} = 174.0°$; $\theta_{p2} = 70.6°$
toward the load: $\theta_{s1} = 168.6°$; $\theta_{p1} = 112.1°$ **or** $\theta_{s2} = 27.6°$; $\theta_{p2} = 67.9°$

Subject no. 33

1. $Z = 20.31 + j\cdot(-29.10)$; $\Gamma = (Z - Z_0)/(Z + Z_0) = -0.214 + j\cdot(-0.503) = 0.546\angle -113.1°$, plot point in complex plane either with rectangular coordinates or polar coordinates

2. $y = 1.130 - j\cdot 0.840$; $Z = Z_0 / (1.130 - j\cdot 0.840) = 28.499\Omega + j\cdot(21.1854)\Omega$

3. a) Pin = 2.00mW = 3.010dBm; Pc = 3.010dBm - 6.90dB = -3.890 dBm = 0.4083mW
Ideal lossless coupler: P_T = 2.00mW – 0.4083mW = 1.5917 mW= 2.018 dBm ; after amplifier G_1 we have $P_{A1} = P_T + G_1$ = 2.018 dBm + 6.7dB = 8.718 dBm ; inside the filter passband maximum attenuation introduced by the filter is equal to the ripple, $P_{out,max} = P_{A1}$ = 8.718 dBm = 7.44mW, $P_{out,min} = P_{A1} - R$ = 8.718 dBm – 2.0dB = 6.718 dBm = 4.697 mW
b) $P_{meas} = P_C + G_2$ = -3.890 dBm + 9.5dB = 5.610 dBm = 3.639 mW
c) Outside the passband $P_{out} = P_{A1} - A$ = 8.718 dBm – 20.1dB = -11.382 dBm = 0.073 mW

4. $\Gamma = (Z - Z_0)/(Z + Z_0) = 0.300 + j\cdot(-0.339) = 0.452\angle -48.511°$;
b) Complex calculus from L7/L8, 2 solutions for the match, $Z_0 = 50\Omega$ lines
$\theta_{S1} = 82.7°$; $Im(y_S) = -1.015$; $\theta_{p1} = 134.6°$ **and** $\theta_{S2} = 145.8°$; $Im(y_S) = 1.015$; $\theta_{p2} = 45.4°$
c) Obviously the shunt stub θ_p is towards the 50 ohm source

5. In any order we cascade the two devices the gain will be the same $G = G_1 + G_2$ = 9.3dB + 11.6dB = 20.9dB. The "best" placement for the two devices refers to the minimum noise factor.
F_1 = 1.16dB=1.306, F_2 = 0.94dB=1.242, G_1 = 9.3dB = 8.511, G_2 = 11.6dB = 14.454
We compute $F_{12} = F_1 + (F_2-1)/G_1 = 1.335$ and $F_{21} = F_2 + (F_1-1)/G_2 = 1.263$, we obtain a lower noise factor when we first use device 2 in the cascade. The result is F = 1.013dB and G = 20.9dB

6. a) The match for maximum gain is available only if the transistor is unconditionally stable.
$|S_{11}| = 0.603 < 1$; $|S_{22}| = 0.559 < 1$; $K = 1.195 > 1$; $|\Delta| = |(0.229) + j\cdot(-0.082)| = 0.243 < 1$
b) $B_1 = 0.992$; $C_1 = (-0.198) + j\cdot(0.443)$; $\Gamma_S = (-0.329) + j\cdot(-0.736) = 0.807\angle -114.1°$
$B_2 = 0.890$; $C_2 = (-0.431) + j\cdot(-0.032)$; $\Gamma_L = (-0.784) + j\cdot(0.059) = 0.786\angle 175.7°$
c) towards the source: $\theta_{s1} = 128.9°$; $\theta_{p1} = 110.1°$ **or** $\theta_{s2} = 165.2°$; $\theta_{p2} = 69.9°$
toward the load: $\theta_{s1} = 163.1°$; $\theta_{p1} = 111.4°$ **or** $\theta_{s2} = 21.2°$; $\theta_{p2} = 68.6°$

Subject no. 34

1. $Z = 25.58 + j\cdot(26.48)$; $\Gamma = (Z - Z_0)/(Z + Z_0) = -0.178 + j\cdot(0.413) = 0.450\angle 113.4°$, plot point in complex plane either with rectangular coordinates or polar coordinates

2. $y = 1.160 - j\cdot 1.010$; $Z = Z_0 / (1.160 - j\cdot 1.010) = 24.517\Omega + j\cdot(21.3467)\Omega$

3. a) Pin = 3.65mW = 5.623dBm; Pc = 5.623dBm - 5.85dB = -0.227 dBm = 0.9491mW
Ideal lossless coupler: P_T = 3.65mW – 0.9491mW = 2.7009 mW= 4.315 dBm ; after amplifier G_1 we have $P_{A1} = P_T + G_1$ = 4.315 dBm + 8.3dB = 12.615 dBm ; inside the filter passband maximum attenuation introduced by the filter is equal to the ripple, $P_{out,max} = P_{A1}$ = 12.615 dBm = 18.26mW, $P_{out,min} = P_{A1} - R$ = 12.615 dBm – 0.6dB = 12.015 dBm = 15.904 mW
b) $P_{meas} = P_C + G_2$ = -0.227 dBm + 8.0dB = 7.773 dBm = 5.988 mW
c) Outside the passband $P_{out} = P_{A1} - A$ = 12.615 dBm – 15.9dB = -3.285 dBm = 0.469 mW

4. $\Gamma = (Z - Z_0)/(Z + Z_0) = 0.270 + j\cdot(-0.297) = 0.401\angle -47.755°$;
b) Complex calculus from L7/L8, 2 solutions for the match, $Z_0 = 50\Omega$ lines
$\theta_{S1} = 80.7°$; $Im(y_S) = -0.876$; $\theta_{p1} = 138.8°$ **and** $\theta_{S2} = 147.0°$; $Im(y_S) = 0.876$; $\theta_{p2} = 41.2°$
c) Obviously the shunt stub θ_p is towards the 50 ohm source

5. In any order we cascade the two devices the gain will be the same $G = G_1 + G_2$ = 8.0dB + 10.8dB = 18.8dB. The "best" placement for the two devices refers to the minimum noise factor.
F_1 = 1.14dB=1.300, F_2 = 0.95dB=1.245, G_1 = 8.0dB = 6.310, G_2 = 10.8dB = 12.023
We compute $F_{12} = F_1 + (F_2-1)/G_1 = 1.339$ and $F_{21} = F_2 + (F_1-1)/G_2 = 1.269$, we obtain a lower noise factor when we first use device 2 in the cascade. The result is F = 1.036dB and G = 18.8dB

6. a) The match for maximum gain is available only if the transistor is unconditionally stable.
$|S_{11}| = 0.633 < 1$; $|S_{22}| = 0.550 < 1$; $K = 1.218 > 1$; $|\Delta| = |(0.262) + j\cdot(0.015)| = 0.263 < 1$
b) $B_1 = 1.029$; $C_1 = (-0.319) + j\cdot(0.390)$; $\Gamma_S = (-0.516) + j\cdot(-0.630) = 0.814\angle -129.3°$
$B_2 = 0.833$; $C_2 = (-0.391) + j\cdot(-0.099)$; $\Gamma_L = (-0.750) + j\cdot(0.190) = 0.774\angle 165.8°$
c) towards the source: $\theta_{s1} = 136.9°$; $\theta_{p1} = 109.6°$ **or** $\theta_{s2} = 172.4°$; $\theta_{p2} = 70.4°$
toward the load: $\theta_{s1} = 167.5°$; $\theta_{p1} = 112.2°$ **or** $\theta_{s2} = 26.7°$; $\theta_{p2} = 67.8°$

Subject no. 35

1. $Z = 25.83 + j\cdot(-20.44)$; $\Gamma = (Z - Z_0)/(Z + Z_0) = -0.229 + j\cdot(-0.331) = 0.403\angle{-124.7°}$, plot point in complex plane either with rectangular coordinates or polar coordinates

2. $y = 0.970 - j\cdot 0.775$; $Z = Z_0 / (0.970 - j\cdot 0.775) = 31.462\Omega + j\cdot(25.1374)\Omega$

3. a) Pin = 2.85mW = 4.548dBm; Pc = 4.548dBm - 4.25dB = 0.298 dBm = 1.0711mW
Ideal lossless coupler: P_T = 2.85mW – 1.0711mW = 1.7789 mW= 2.501 dBm ; after amplifier G_1 we have $P_{A1} = P_T + G_1$ = 2.501 dBm + 9.9dB = 12.401 dBm ; inside the filter passband maximum attenuation introduced by the filter is equal to the ripple, $P_{out,max} = P_{A1}$ = 12.401 dBm = 17.38mW, $P_{out,min} = P_{A1} - R$ = 12.401 dBm – 1.5dB = 10.901 dBm = 12.307 mW
b) $P_{meas} = P_C + G_2$ = 0.298 dBm + 8.9dB = 9.198 dBm = 8.315 mW
c) Outside the passband $P_{out} = P_{A1} - A$ = 12.401 dBm – 15.5dB = -3.099 dBm = 0.490 mW

4. $\Gamma = (Z - Z_0)/(Z + Z_0) = 0.356 + j\cdot(0.401) = 0.536\angle 48.393°$;
b) Complex calculus from L7/L8, 2 solutions for the match, $Z_0 = 50\Omega$ lines
$\theta_{S1} = 37.0°$; $Im(y_S) = -1.271$; $\theta_{p1} = 128.2°$ **and** $\theta_{S2} = 94.6°$; $Im(y_S) = 1.271$; $\theta_{p2} = 51.8°$
c) Obviously the shunt stub θ_p is towards the 50 ohm source

5. In any order we cascade the two devices the gain will be the same $G = G_1 + G_2$ = 8.0dB + 11.9dB = 19.9dB. The "best" placement for the two devices refers to the minimum noise factor.
F_1 = 1.20dB=1.318, F_2 = 0.98dB=1.253, G_1 = 8.0dB = 6.310, G_2 = 11.9dB = 15.488
We compute $F_{12} = F_1 + (F_2-1)/G_1 = 1.358$ and $F_{21} = F_2 + (F_1-1)/G_2 = 1.274$, we obtain a lower noise factor when we first use device 2 in the cascade. The result is F = 1.051dB and G = 19.9dB

6. a) The match for maximum gain is available only if the transistor is unconditionally stable.
$|S_{11}| = 0.624 < 1$; $|S_{22}| = 0.552 < 1$; $K = 1.223 > 1$; $|\Delta| = |(0.251) + j\cdot(-0.034)| = 0.253 < 1$
b) $B_1 = 1.021$; $C_1 = (-0.273) + j\cdot(0.418)$; $\Gamma_S = (-0.443) + j\cdot(-0.677) = 0.809\angle{-123.2°}$
$B_2 = 0.851$; $C_2 = (-0.405) + j\cdot(-0.074)$; $\Gamma_L = (-0.762) + j\cdot(0.140) = 0.774\angle 169.6°$
c) towards the source: $\theta_{s1} = 133.6°$; $\theta_{p1} = 110.0°$ **or** $\theta_{s2} = 169.6°$; $\theta_{p2} = 70.0°$
toward the load: $\theta_{s1} = 165.6°$; $\theta_{p1} = 112.2°$ **or** $\theta_{s2} = 24.8°$; $\theta_{p2} = 67.8°$

Subject no. 36

1. $Z = 20.85 + j\cdot(-27.83)$; $\Gamma = (Z - Z_0)/(Z + Z_0) = -0.223 + j\cdot(-0.480) = 0.529\angle{-114.9°}$, plot point in complex plane either with rectangular coordinates or polar coordinates

2. $y = 1.290 + j\cdot1.015$; $Z = Z_0 / (1.290 + j\cdot1.015) = 23.939\Omega + j\cdot(-18.8359)\Omega$

3. a) Pin = 2.35mW = 3.711dBm; Pc = 3.711dBm - 4.50dB = -0.789 dBm = 0.8338mW
Ideal lossless coupler: P_T = 2.35mW – 0.8338mW = 1.5162 mW= 1.808 dBm ; after amplifier G_1 we have $P_{A1} = P_T + G_1$ = 1.808 dBm + 6.8dB = 8.608 dBm ; inside the filter passband maximum attenuation introduced by the filter is equal to the ripple, $P_{out,max} = P_{A1}$ = 8.608 dBm = 7.26mW, $P_{out,min} = P_{A1} - R$ = 8.608 dBm – 2.4dB = 6.208 dBm = 4.176 mW
b) $P_{meas} = P_C + G_2$ = -0.789 dBm + 9.6dB = 8.811 dBm = 7.604 mW
c) Outside the passband $P_{out} = P_{A1} - A$ = 8.608 dBm – 18.4dB = -9.792 dBm = 0.105 mW

4. $\Gamma = (Z - Z_0)/(Z + Z_0) = 0.132 + j\cdot(0.435) = 0.454\angle 73.134°$;
b) Complex calculus from L7/L8, 2 solutions for the match, $Z_0 = 50\Omega$ lines
$\theta_{S1} = 21.9°$; $Im(y_S) = -1.019$; $\theta_{p1} = 134.4°$ **and** $\theta_{S2} = 84.9°$; $Im(y_S) = 1.019$; $\theta_{p2} = 45.6°$
c) Obviously the shunt stub θ_p is towards the 50 ohm source

5. In any order we cascade the two devices the gain will be the same $G = G_1 + G_2$ = 9.5dB + 10.2dB = 19.7dB. The "best" placement for the two devices refers to the minimum noise factor.
F_1 = 1.14dB=1.300, F_2 = 1.04dB=1.271, G_1 = 9.5dB = 8.913, G_2 = 10.2dB = 10.471
We compute $F_{12} = F_1 + (F_2-1)/G_1 = 1.331$ and $F_{21} = F_2 + (F_1-1)/G_2 = 1.299$, we obtain a lower noise factor when we first use device 2 in the cascade. The result is F = 1.137dB and G = 19.7dB

6. a) The match for maximum gain is available only if the transistor is unconditionally stable.
$|S_{11}| = 0.637 < 1$; $|S_{22}| = 0.550 < 1$; $K = 1.201 > 1$; $|\Delta| = |(0.265) + j\cdot(0.060)| = 0.272 < 1$
b) $B_1 = 1.029$; $C_1 = (-0.351) + j\cdot(0.363)$; $\Gamma_S = (-0.570) + j\cdot(-0.589) = 0.819\angle{-134.1°}$
$B_2 = 0.823$; $C_2 = (-0.381) + j\cdot(-0.116)$; $\Gamma_L = (-0.744) + j\cdot(0.227) = 0.778\angle 163.0°$
c) towards the source: $\theta_{s1} = 139.5°$; $\theta_{p1} = 109.3°$ **or** $\theta_{s2} = 174.5°$; $\theta_{p2} = 70.7°$
toward the load: $\theta_{s1} = 169.0°$; $\theta_{p1} = 112.0°$ **or** $\theta_{s2} = 27.9°$; $\theta_{p2} = 68.0°$

Subject no. 37

1. $Z = 17.33 + j\cdot(15.39)$; $\Gamma = (Z - Z_0)/(Z + Z_0) = -0.411 + j\cdot(0.323) = 0.523\angle 141.9°$, plot point in complex plane either with rectangular coordinates or polar coordinates

2. $y = 1.010 - j\cdot 0.920$; $Z = Z_0 / (1.010 - j\cdot 0.920) = 27.056\Omega + j\cdot(24.6451)\Omega$

3. a) Pin = 4.00mW = 6.021dBm; Pc = 6.021dBm - 6.15dB = -0.129 dBm = 0.9706mW
Ideal lossless coupler: P_T = 4.00mW – 0.9706mW = 3.0294 mW= 4.814 dBm ; after amplifier G_1 we have $P_{A1} = P_T + G_1$ = 4.814 dBm + 8.4dB = 13.214 dBm ; inside the filter passband maximum attenuation introduced by the filter is equal to the ripple, $P_{out,max} = P_{A1}$ = 13.214 dBm = 20.96mW, $P_{out,min} = P_{A1} - R$ = 13.214 dBm – 2.1dB = 11.114 dBm = 12.923 mW
b) $P_{meas} = P_C + G_2$ = -0.129 dBm + 8.9dB = 8.771 dBm = 7.535 mW
c) Outside the passband $P_{out} = P_{A1} - A$ = 13.214 dBm – 21.1dB = -7.886 dBm = 0.163 mW

4. $\Gamma = (Z - Z_0)/(Z + Z_0) = 0.151 + j\cdot(0.549) = 0.569\angle 74.598°$;
b) Complex calculus from L7/L8, 2 solutions for the match, $Z_0 = 50\Omega$ lines
$\theta_{S1} = 25.0°$; $Im(y_S) = -1.384$; $\theta_{p1} = 125.9°$ **and** $\theta_{S2} = 80.4°$; $Im(y_S) = 1.384$; $\theta_{p2} = 54.1°$
c) Obviously the shunt stub θ_p is towards the 50 ohm source

5. In any order we cascade the two devices the gain will be the same $G = G_1 + G_2$ = 9.9dB + 11.8dB = 21.7dB. The "best" placement for the two devices refers to the minimum noise factor.
F_1 = 1.14dB=1.300, F_2 = 1.09dB=1.285, G_1 = 9.9dB = 9.772, G_2 = 11.8dB = 15.136
We compute $F_{12} = F_1 + (F_2 - 1)/G_1 = 1.329$ and $F_{21} = F_2 + (F_1 - 1)/G_2 = 1.305$, we obtain a lower noise factor when we first use device 2 in the cascade. The result is F = 1.157dB and G = 21.7dB

6. a) The match for maximum gain is available only if the transistor is unconditionally stable.
$|S_{11}| = 0.627 < 1$; $|S_{22}| = 0.551 < 1$; $K = 1.227 > 1$; $|\Delta| = |(0.253) + j\cdot(-0.026)| = 0.255 < 1$
b) $B_1 = 1.025$; $C_1 = (-0.284) + j\cdot(0.413)$; $\Gamma_S = (-0.458) + j\cdot(-0.667) = 0.809\angle -124.5°$
$B_2 = 0.846$; $C_2 = (-0.401) + j\cdot(-0.080)$; $\Gamma_L = (-0.758) + j\cdot(0.151) = 0.773\angle 168.7°$
c) towards the source: $\theta_{s1} = 134.3°$; $\theta_{p1} = 109.9°$ **or** $\theta_{s2} = 170.2°$; $\theta_{p2} = 70.1°$
toward the load: $\theta_{s1} = 165.9°$; $\theta_{p1} = 112.3°$ **or** $\theta_{s2} = 25.3°$; $\theta_{p2} = 67.7°$

Subject no. 38

1. $Z = 31.57 + j\cdot(-20.59)$; $\Gamma = (Z - Z_0)/(Z + Z_0) = -0.153 + j\cdot(-0.291) = 0.329\angle -117.7°$, plot point in complex plane either with rectangular coordinates or polar coordinates

2. $y = 0.980 + j\cdot 0.970$; $Z = Z_0 / (0.980 + j\cdot 0.970) = 25.772\Omega + j\cdot(-25.5089)\Omega$

3. a) Pin = 1.85mW = 2.672dBm; Pc = 2.672dBm - 4.70dB = -2.028 dBm = 0.6269mW
Ideal lossless coupler: P_T = 1.85mW – 0.6269mW = 1.2231 mW= 0.875 dBm ; after amplifier G_1 we have $P_{A1} = P_T + G_1$ = 0.875 dBm + 9.0dB = 9.875 dBm ; inside the filter passband maximum attenuation introduced by the filter is equal to the ripple, $P_{out,max} = P_{A1}$ = 9.875 dBm = 9.72mW, $P_{out,min} = P_{A1} - R$ = 9.875 dBm – 2.5dB = 7.375 dBm = 5.464 mW
b) $P_{meas} = P_C + G_2$ = -2.028 dBm + 9.7dB = 7.672 dBm = 5.850 mW
c) Outside the passband $P_{out} = P_{A1} - A$ = 9.875 dBm – 22.7dB = -12.825 dBm = 0.052 mW

4. $\Gamma = (Z - Z_0)/(Z + Z_0) = 0.350 + j\cdot(0.403) = 0.534\angle 49.042°$;
b) Complex calculus from L7/L8, 2 solutions for the match, $Z_0 = 50\Omega$ lines
$\theta_{S1} = 36.6°$; $Im(y_S) = -1.263$; $\theta_{p1} = 128.4°$ **and** $\theta_{S2} = 94.3°$; $Im(y_S) = 1.263$; $\theta_{p2} = 51.6°$
c) Obviously the shunt stub θ_p is towards the 50 ohm source

5. In any order we cascade the two devices the gain will be the same $G = G_1 + G_2$ = 9.8dB + 10.4dB = 20.2dB. The "best" placement for the two devices refers to the minimum noise factor.
F_1 = 1.22dB=1.324, F_2 = 0.98dB=1.253, G_1 = 9.8dB = 9.550, G_2 = 10.4dB = 10.965
We compute $F_{12} = F_1 + (F_2-1)/G_1 = 1.351$ and $F_{21} = F_2 + (F_1-1)/G_2 = 1.283$, we obtain a lower noise factor when we first use device 2 in the cascade. The result is F = 1.081dB and G = 20.2dB

6. a) The match for maximum gain is available only if the transistor is unconditionally stable.
$|S_{11}| = 0.611 < 1$; $|S_{22}| = 0.520 < 1$; $K = 1.146 > 1$; $|\Delta| = |(-0.060) + j\cdot(0.264)| = 0.271 < 1$
b) $B_1 = 1.030$; $C_1 = (-0.495) + j\cdot(0.096)$; $\Gamma_S = (-0.798) + j\cdot(-0.155) = 0.813\angle -169.0°$
$B_2 = 0.824$; $C_2 = (-0.233) + j\cdot(-0.323)$; $\Gamma_L = (-0.451) + j\cdot(0.625) = 0.770\angle 125.8°$
c) towards the source: $\theta_{s1} = 156.7°$; $\theta_{p1} = 109.7°$ **or** $\theta_{s2} = 12.3°$; $\theta_{p2} = 70.3°$
toward the load: $\theta_{s1} = 7.3°$; $\theta_{p1} = 112.5°$ **or** $\theta_{s2} = 46.9°$; $\theta_{p2} = 67.5°$

Subject no. 39

1. $Z = 31.76 + j\cdot(-33.45)$; $\Gamma = (Z - Z_0)/(Z + Z_0) = -0.048 + j\cdot(-0.429) = 0.431\angle -96.4°$, plot point in complex plane either with rectangular coordinates or polar coordinates

2. $y = 0.920 - j\cdot 1.225$; $Z = Z_0 / (0.920 - j\cdot 1.225) = 19.599\Omega + j\cdot(26.0969)\Omega$

3. a) Pin = 2.05mW = 3.118dBm; Pc = 3.118dBm - 5.10dB = -1.982 dBm = 0.6335mW
Ideal lossless coupler: P_T = 2.05mW – 0.6335mW = 1.4165 mW= 1.512 dBm ; after amplifier G_1 we have $P_{A1} = P_T + G_1$ = 1.512 dBm + 9.6dB = 11.112 dBm ; inside the filter passband maximum attenuation introduced by the filter is equal to the ripple, $P_{out,max} = P_{A1}$ = 11.112 dBm = 12.92mW, $P_{out,min} = P_{A1} - R$ = 11.112 dBm – 1.8dB = 9.312 dBm = 8.535 mW
b) $P_{meas} = P_C + G_2$ = -1.982 dBm + 8.5dB = 6.518 dBm = 4.485 mW
c) Outside the passband $P_{out} = P_{A1} - A$ = 11.112 dBm – 21.7dB = -10.588 dBm = 0.087 mW

4. $\Gamma = (Z - Z_0)/(Z + Z_0) = 0.118 + j\cdot(0.290) = 0.313\angle 67.902°$;
b) Complex calculus from L7/L8, 2 solutions for the match, $Z_0 = 50\Omega$ lines
$\theta_{S1} = 20.2°$; $Im(y_S) = -0.659$; $\theta_{p1} = 146.6°$ **and** $\theta_{S2} = 91.9°$; $Im(y_S) = 0.659$; $\theta_{p2} = 33.4°$
c) Obviously the shunt stub θ_p is towards the 50 ohm source

5. In any order we cascade the two devices the gain will be the same $G = G_1 + G_2$ = 9.6dB + 11.3dB = 20.9dB. The "best" placement for the two devices refers to the minimum noise factor.
F_1 = 1.14dB=1.300, F_2 = 1.01dB=1.262, G_1 = 9.6dB = 9.120, G_2 = 11.3dB = 13.490
We compute $F_{12} = F_1 + (F_2-1)/G_1 = 1.329$ and $F_{21} = F_2 + (F_1-1)/G_2 = 1.284$, we obtain a lower noise factor when we first use device 2 in the cascade. The result is F = 1.086dB and G = 20.9dB

6. a) The match for maximum gain is available only if the transistor is unconditionally stable.
$|S_{11}| = 0.630 < 1$; $|S_{22}| = 0.550 < 1$; $K = 1.231 > 1$; $|\Delta| = |(0.255) + j\cdot(-0.019)| = 0.256 < 1$
b) $B_1 = 1.029$; $C_1 = (-0.294) + j\cdot(0.408)$; $\Gamma_S = (-0.473) + j\cdot(-0.657) = 0.810\angle -125.8°$
$B_2 = 0.840$; $C_2 = (-0.397) + j\cdot(-0.085)$; $\Gamma_L = (-0.754) + j\cdot(0.162) = 0.771\angle 167.9°$
c) towards the source: $\theta_{s1} = 134.9°$; $\theta_{p1} = 109.9°$ **or** $\theta_{s2} = 170.8°$; $\theta_{p2} = 70.1°$
toward the load: $\theta_{s1} = 166.3°$; $\theta_{p1} = 112.4°$ **or** $\theta_{s2} = 25.8°$; $\theta_{p2} = 67.6°$

Subject no. 40

1. $Z = 39.00 + j\cdot(-25.45)$; $\Gamma = (Z - Z_0)/(Z + Z_0) = -0.039 + j\cdot(-0.297) = 0.299\angle{-97.4°}$, plot point in complex plane either with rectangular coordinates or polar coordinates

2. $y = 0.805 - j\cdot1.050$; $Z = Z_0 / (0.805 - j\cdot1.050) = 22.993\Omega + j\cdot(29.9910)\Omega$

3. a) Pin = 4.00mW = 6.021dBm; Pc = 6.021dBm - 6.85dB = -0.829 dBm = 0.8262mW
Ideal lossless coupler: P_T = 4.00mW – 0.8262mW = 3.1738 mW= 5.016 dBm ; after amplifier G_1 we have $P_{A1} = P_T + G_1$ = 5.016 dBm + 6.9dB = 11.916 dBm ; inside the filter passband maximum attenuation introduced by the filter is equal to the ripple, $P_{out,max} = P_{A1}$ = 11.916 dBm = 15.54mW, $P_{out,min} = P_{A1} - R$ = 11.916 dBm – 1.9dB = 10.016 dBm = 10.037 mW
b) $P_{meas} = P_C + G_2$ = -0.829 dBm + 8.4dB = 7.571 dBm = 5.716 mW
c) Outside the passband $P_{out} = P_{A1} - A$ = 11.916 dBm – 16.1dB = -4.184 dBm = 0.382 mW

4. $\Gamma = (Z - Z_0)/(Z + Z_0) = 0.296 + j\cdot(-0.450) = 0.539\angle{-56.612°}$;
b) Complex calculus from L7/L8, 2 solutions for the match, $Z_0 = 50\Omega$ lines
$\theta_{S1} = 89.6°$; $Im(y_S) = -1.279$; $\theta_{p1} = 128.0°$ **and** $\theta_{S2} = 147.0°$; $Im(y_S) = 1.279$; $\theta_{p2} = 52.0°$
c) Obviously the shunt stub θ_p is towards the 50 ohm source

5. In any order we cascade the two devices the gain will be the same $G = G_1 + G_2$ = 9.4dB + 11.2dB = 20.6dB. The "best" placement for the two devices refers to the minimum noise factor.
F_1 = 1.24dB=1.330, F_2 = 1.08dB=1.282, G_1 = 9.4dB = 8.710, G_2 = 11.2dB = 13.183
We compute $F_{12} = F_1 + (F_2-1)/G_1 = 1.363$ and $F_{21} = F_2 + (F_1-1)/G_2 = 1.307$, we obtain a lower noise factor when we first use device 2 in the cascade. The result is F = 1.164dB and G = 20.6dB

6. a) The match for maximum gain is available only if the transistor is unconditionally stable.
$|S_{11}| = 0.647 < 1$; $|S_{22}| = 0.520 < 1$; $K = 1.100 > 1$; $|\Delta| = |(-0.129) + j\cdot(0.249)| = 0.280 < 1$
b) $B_1 = 1.070$; $C_1 = (-0.525) + j\cdot(-0.059)$; $\Gamma_S = (-0.853) + j\cdot(0.095) = 0.858\angle{173.6°}$
$B_2 = 0.773$; $C_2 = (-0.209) + j\cdot(-0.315)$; $\Gamma_L = (-0.448) + j\cdot(0.673) = 0.808\angle{123.6°}$
c) towards the source: $\theta_{s1} = 167.7°$; $\theta_{p1} = 106.6°$ **or** $\theta_{s2} = 18.6°$; $\theta_{p2} = 73.4°$
toward the load: $\theta_{s1} = 10.2°$; $\theta_{p1} = 110.0°$ **or** $\theta_{s2} = 46.2°$; $\theta_{p2} = 70.0°$

Subject no. 41

1. $Z = 20.83 + j\cdot(-22.44)$; $\Gamma = (Z - Z_0)/(Z + Z_0) = -0.283 + j\cdot(-0.406) = 0.495\angle -124.9°$, plot point in complex plane either with rectangular coordinates or polar coordinates

2. $y = 1.130 - j\cdot 0.915$; $Z = Z_0 / (1.130 - j\cdot 0.915) = 26.725\Omega + j\cdot(21.6402)\Omega$

3. a) Pin = 2.85mW = 4.548dBm; Pc = 4.548dBm - 6.45dB = -1.902 dBm = 0.6454mW
Ideal lossless coupler: P_T = 2.85mW – 0.6454mW = 2.2046 mW= 3.433 dBm ; after amplifier G_1 we have $P_{A1} = P_T + G_1$ = 3.433 dBm + 7.1dB = 10.533 dBm ; inside the filter passband maximum attenuation introduced by the filter is equal to the ripple, $P_{out,max} = P_{A1}$ = 10.533 dBm = 11.31mW, $P_{out,min} = P_{A1} - R$ = 10.533 dBm – 2.7dB = 7.833 dBm = 6.072 mW
b) $P_{meas} = P_C + G_2$ = -1.902 dBm + 11.2dB = 9.298 dBm = 8.508 mW
c) Outside the passband $P_{out} = P_{A1} - A$ = 10.533 dBm – 18.1dB = -7.567 dBm = 0.175 mW

4. $\Gamma = (Z - Z_0)/(Z + Z_0) = 0.243 + j\cdot(0.338) = 0.416\angle 54.229°$;
b) Complex calculus from L7/L8, 2 solutions for the match, $Z_0 = 50\Omega$ lines
$\theta_{S1} = 30.2°$; $Im(y_S) = -0.916$; $\theta_{p1} = 137.5°$ **and** $\theta_{S2} = 95.6°$; $Im(y_S) = 0.916$; $\theta_{p2} = 42.5°$
c) Obviously the shunt stub θ_p is towards the 50 ohm source

5. In any order we cascade the two devices the gain will be the same $G = G_1 + G_2$ = 9.5dB + 11.2dB = 20.7dB. The "best" placement for the two devices refers to the minimum noise factor.
F_1 = 1.25dB=1.334, F_2 = 0.94dB=1.242, G_1 = 9.5dB = 8.913, G_2 = 11.2dB = 13.183
We compute $F_{12} = F_1 + (F_2-1)/G_1 = 1.361$ and $F_{21} = F_2 + (F_1-1)/G_2 = 1.267$, we obtain a lower noise factor when we first use device 2 in the cascade. The result is F = 1.028dB and G = 20.7dB

6. a) The match for maximum gain is available only if the transistor is unconditionally stable.
$|S_{11}| = 0.659 < 1$; $|S_{22}| = 0.517 < 1$; $K = 1.074 > 1$; $|\Delta| = |(-0.182) + j\cdot(0.231)| = 0.294 < 1$
b) $B_1 = 1.081$; $C_1 = (-0.525) + j\cdot(-0.105)$; $\Gamma_S = (-0.860) + j\cdot(0.172) = 0.877\angle 168.7°$
$B_2 = 0.747$; $C_2 = (-0.180) + j\cdot(-0.319)$; $\Gamma_L = (-0.406) + j\cdot(0.720) = 0.827\angle 119.4°$
c) towards the source: $\theta_{s1} = 171.3°$; $\theta_{p1} = 105.3°$ **or** $\theta_{s2} = 20.0°$; $\theta_{p2} = 74.7°$
toward the load: $\theta_{s1} = 13.2°$; $\theta_{p1} = 108.8°$ **or** $\theta_{s2} = 47.4°$; $\theta_{p2} = 71.2°$

Subject no. 42

1. $Z = 18.60 + j\cdot(16.37)$; $\Gamma = (Z - Z_0)/(Z + Z_0) = -0.379 + j\cdot(0.329) = 0.502\angle 139.1°$, plot point in complex plane either with rectangular coordinates or polar coordinates

2. $y = 0.880 - j\cdot 1.205$; $Z = Z_0 / (0.880 - j\cdot 1.205) = 19.763\Omega + j\cdot(27.0613)\Omega$

3. a) Pin = 3.15mW = 4.983dBm; Pc = 4.983dBm - 4.75dB = 0.233 dBm = 1.0551mW
Ideal lossless coupler: P_T = 3.15mW – 1.0551mW = 2.0949 mW= 3.212 dBm ; after amplifier G_1 we have $P_{A1} = P_T + G_1$ = 3.212 dBm + 6.5dB = 9.712 dBm ; inside the filter passband maximum attenuation introduced by the filter is equal to the ripple, $P_{out,max} = P_{A1}$ = 9.712 dBm = 9.36mW, $P_{out,min} = P_{A1} - R$ = 9.712 dBm – 0.9dB = 8.812 dBm = 7.606 mW
b) $P_{meas} = P_C + G_2$ = 0.233 dBm + 10.6dB = 10.833 dBm = 12.115 mW
c) Outside the passband $P_{out} = P_{A1} - A$ = 9.712 dBm – 21.9dB = -12.188 dBm = 0.060 mW

4. $\Gamma = (Z - Z_0)/(Z + Z_0) = 0.277 + j\cdot(0.334) = 0.434\angle 50.313°$;
b) Complex calculus from L7/L8, 2 solutions for the match, $Z_0 = 50\Omega$ lines
$\theta_{S1} = 32.7°$; $Im(y_S) = -0.964$; $\theta_{p1} = 136.1°$ **and** $\theta_{S2} = 97.0°$; $Im(y_S) = 0.964$; $\theta_{p2} = 43.9°$
c) Obviously the shunt stub θ_p is towards the 50 ohm source

5. In any order we cascade the two devices the gain will be the same $G = G_1 + G_2$ = 9.1dB + 10.4dB = 19.5dB. The "best" placement for the two devices refers to the minimum noise factor.
F_1 = 1.21dB=1.321, F_2 = 1.03dB=1.268, G_1 = 9.1dB = 8.128, G_2 = 10.4dB = 10.965
We compute $F_{12} = F_1 + (F_2-1)/G_1 = 1.354$ and $F_{21} = F_2 + (F_1-1)/G_2 = 1.297$, we obtain a lower noise factor when we first use device 2 in the cascade. The result is F = 1.129dB and G = 19.5dB

6. a) The match for maximum gain is available only if the transistor is unconditionally stable.
$|S_{11}| = 0.639 < 1$; $|S_{22}| = 0.550 < 1$; $K = 1.193 > 1$; $|\Delta| = |(0.264) + j\cdot(0.084)| = 0.277 < 1$
b) $B_1 = 1.029$; $C_1 = (-0.366) + j\cdot(0.348)$; $\Gamma_S = (-0.595) + j\cdot(-0.566) = 0.822\angle -136.4°$
$B_2 = 0.818$; $C_2 = (-0.376) + j\cdot(-0.125)$; $\Gamma_L = (-0.740) + j\cdot(0.245) = 0.779\angle 161.7°$
c) towards the source: $\theta_{s1} = 140.8°$; $\theta_{p1} = 109.1°$ **or** $\theta_{s2} = 175.6°$; $\theta_{p2} = 70.9°$
toward the load: $\theta_{s1} = 169.8°$; $\theta_{p1} = 111.9°$ **or** $\theta_{s2} = 28.6°$; $\theta_{p2} = 68.1°$

Subject no. 43

1. $Z = 16.68 + j\cdot(-22.11)$; $\Gamma = (Z - Z_0)/(Z + Z_0) = -0.351 + j\cdot(-0.448) = 0.569\angle{-128.1°}$, plot point in complex plane either with rectangular coordinates or polar coordinates

2. $y = 0.870 + j\cdot 1.140$; $Z = Z_0 / (0.870 + j\cdot 1.140) = 21.152\Omega + j\cdot(-27.7170)\Omega$

3. a) Pin = 2.15mW = 3.324dBm; Pc = 3.324dBm - 4.90dB = -1.576 dBm = 0.6957mW
Ideal lossless coupler: P_T = 2.15mW – 0.6957mW = 1.4543 mW= 1.626 dBm ; after amplifier G_1 we have $P_{A1} = P_T + G_1$ = 1.626 dBm + 8.6dB = 10.226 dBm ; inside the filter passband maximum attenuation introduced by the filter is equal to the ripple, $P_{out,max} = P_{A1}$ = 10.226 dBm = 10.54mW, $P_{out,min} = P_{A1} - R$ = 10.226 dBm – 2.3dB = 7.926 dBm = 6.204 mW
b) $P_{meas} = P_C + G_2$ = -1.576 dBm + 10.3dB = 8.724 dBm = 7.455 mW
c) Outside the passband $P_{out} = P_{A1} - A$ = 10.226 dBm – 23.7dB = -13.474 dBm = 0.045 mW

4. $\Gamma = (Z - Z_0)/(Z + Z_0) = 0.308 + j\cdot(-0.475) = 0.567\angle{-57.024°}$;
b) Complex calculus from L7/L8, 2 solutions for the match, $Z_0 = 50\Omega$ lines
$\theta_{S1} = 90.8°$; $Im(y_S) = -1.375$; $\theta_{p1} = 126.0°$ **and** $\theta_{S2} = 146.3°$; $Im(y_S) = 1.375$; $\theta_{p2} = 54.0°$
c) Obviously the shunt stub θ_p is towards the 50 ohm source

5. In any order we cascade the two devices the gain will be the same $G = G_1 + G_2$ = 8.9dB + 11.5dB = 20.4dB. The "best" placement for the two devices refers to the minimum noise factor.
F_1 = 1.25dB=1.334, F_2 = 0.97dB=1.250, G_1 = 8.9dB = 7.762, G_2 = 11.5dB = 14.125
We compute $F_{12} = F_1 + (F_2-1)/G_1 = 1.366$ and $F_{21} = F_2 + (F_1-1)/G_2 = 1.274$, we obtain a lower noise factor when we first use device 2 in the cascade. The result is F = 1.051dB and G = 20.4dB

6. a) The match for maximum gain is available only if the transistor is unconditionally stable.
$|S_{11}| = 0.605 < 1$; $|S_{22}| = 0.520 < 1$; $K = 1.169 > 1$; $|\Delta| = |(-0.037) + j\cdot(0.262)| = 0.264 < 1$
b) $B_1 = 1.026$; $C_1 = (-0.486) + j\cdot(0.119)$; $\Gamma_S = (-0.778) + j\cdot(-0.191) = 0.801\angle{-166.2°}$
$B_2 = 0.835$; $C_2 = (-0.242) + j\cdot(-0.321)$; $\Gamma_L = (-0.457) + j\cdot(0.606) = 0.759\angle{127.0°}$
c) towards the source: $\theta_{s1} = 154.7°$; $\theta_{p1} = 110.5°$ **or** $\theta_{s2} = 11.5°$; $\theta_{p2} = 69.5°$
toward the load: $\theta_{s1} = 6.2°$; $\theta_{p1} = 113.2°$ **or** $\theta_{s2} = 46.8°$; $\theta_{p2} = 66.8°$

Subject no. 44

1. $Z = 24.48 + j\cdot(-20.11)$; $\Gamma = (Z - Z_0)/(Z + Z_0) = -0.251 + j\cdot(-0.338) = 0.421\angle -126.7°$, plot point in complex plane either with rectangular coordinates or polar coordinates

2. $y = 1.010 - j\cdot 0.920$; $Z = Z_0 / (1.010 - j\cdot 0.920) = 27.056\Omega + j\cdot(24.6451)\Omega$

3. a) Pin = 3.45mW = 5.378dBm; Pc = 5.378dBm - 6.25dB = -0.872 dBm = 0.8181mW
Ideal lossless coupler: P_T = 3.45mW – 0.8181mW = 2.6319 mW= 4.203 dBm ; after amplifier G_1 we have $P_{A1} = P_T + G_1$ = 4.203 dBm + 6.3dB = 10.503 dBm ; inside the filter passband maximum attenuation introduced by the filter is equal to the ripple, $P_{out,max} = P_{A1}$ = 10.503 dBm = 11.23mW, $P_{out,min} = P_{A1} - R$ = 10.503 dBm – 1.9dB = 8.603 dBm = 7.249 mW
b) $P_{meas} = P_C + G_2$ = -0.872 dBm + 11.8dB = 10.928 dBm = 12.383 mW
c) Outside the passband $P_{out} = P_{A1} - A$ = 10.503 dBm – 23.8dB = -13.297 dBm = 0.047 mW

4. $\Gamma = (Z - Z_0)/(Z + Z_0) = 0.116 + j\cdot(-0.556) = 0.568\angle -78.170°$;
b) Complex calculus from L7/L8, 2 solutions for the match, $Z_0 = 50\Omega$ lines
$\theta_{S1} = 101.4°$; $Im(y_S) = -1.379$; $\theta_{p1} = 125.9°$ **and** $\theta_{S2} = 156.8°$; $Im(y_S) = 1.379$; $\theta_{p2} = 54.1°$
c) Obviously the shunt stub θ_p is towards the 50 ohm source

5. In any order we cascade the two devices the gain will be the same $G = G_1 + G_2$ = 9.8dB + 10.0dB = 19.8dB. The "best" placement for the two devices refers to the minimum noise factor.
F_1 = 1.21dB=1.321, F_2 = 0.93dB=1.239, G_1 = 9.8dB = 9.550, G_2 = 10.0dB = 10.000
We compute $F_{12} = F_1 + (F_2 - 1)/G_1 = 1.346$ and $F_{21} = F_2 + (F_1 - 1)/G_2 = 1.271$, we obtain a lower noise factor when we first use device 2 in the cascade. The result is F = 1.041dB and G = 19.8dB

6. a) The match for maximum gain is available only if the transistor is unconditionally stable.
$|S_{11}| = 0.608 < 1$; $|S_{22}| = 0.520 < 1$; $K = 1.157 > 1$; $|\Delta| = |(-0.048) + j\cdot(0.263)| = 0.267 < 1$
b) $B_1 = 1.028$; $C_1 = (-0.491) + j\cdot(0.108)$; $\Gamma_S = (-0.788) + j\cdot(-0.173) = 0.807\angle -167.6°$
$B_2 = 0.829$; $C_2 = (-0.238) + j\cdot(-0.322)$; $\Gamma_L = (-0.454) + j\cdot(0.615) = 0.765\angle 126.4°$
c) towards the source: $\theta_{s1} = 155.7°$; $\theta_{p1} = 110.1°$ **or** $\theta_{s2} = 11.9°$; $\theta_{p2} = 69.9°$
toward the load: $\theta_{s1} = 6.7°$; $\theta_{p1} = 112.8°$ **or** $\theta_{s2} = 46.8°$; $\theta_{p2} = 67.2°$

Subject no. 45

1. $Z = 15.52 + j\cdot(-21.02)$; $\Gamma = (Z - Z_0)/(Z + Z_0) = -0.384 + j\cdot(-0.444) = 0.587\angle{-130.8°}$, plot point in complex plane either with rectangular coordinates or polar coordinates

2. $y = 0.740 + j\cdot 1.175$; $Z = Z_0 / (0.740 + j\cdot 1.175) = 19.189\Omega + j\cdot(-30.4684)\Omega$

3. a) Pin = 1.65mW = 2.175dBm; Pc = 2.175dBm - 5.60dB = -3.425 dBm = 0.4544mW
Ideal lossless coupler: P_T = 1.65mW – 0.4544mW = 1.1956 mW= 0.776 dBm ; after amplifier G_1 we have $P_{A1} = P_T + G_1$ = 0.776 dBm + 6.4dB = 7.176 dBm ; inside the filter passband maximum attenuation introduced by the filter is equal to the ripple, $P_{out,max} = P_{A1}$ = 7.176 dBm = 5.22mW, $P_{out,min} = P_{A1} - R$ = 7.176 dBm – 2.1dB = 5.076 dBm = 3.218 mW
b) $P_{meas} = P_C + G_2$ = -3.425 dBm + 9.7dB = 6.275 dBm = 4.241 mW
c) Outside the passband $P_{out} = P_{A1} - A$ = 7.176 dBm – 22.4dB = -15.224 dBm = 0.030 mW

4. $\Gamma = (Z - Z_0)/(Z + Z_0) = 0.258 + j\cdot(0.261) = 0.367\angle 45.363°$;
b) Complex calculus from L7/L8, 2 solutions for the match, $Z_0 = 50\Omega$ lines
$\theta_{S1} = 33.1°$; $Im(y_S) = -0.789$; $\theta_{p1} = 141.7°$ **and** $\theta_{S2} = 101.6°$; $Im(y_S) = 0.789$; $\theta_{p2} = 38.3°$
c) Obviously the shunt stub θ_p is towards the 50 ohm source

5. In any order we cascade the two devices the gain will be the same $G = G_1 + G_2$ = 8.3dB + 11.5dB = 19.8dB. The "best" placement for the two devices refers to the minimum noise factor.
F_1 = 1.20dB=1.318, F_2 = 0.91dB=1.233, G_1 = 8.3dB = 6.761, G_2 = 11.5dB = 14.125
We compute $F_{12} = F_1 + (F_2-1)/G_1 = 1.353$ and $F_{21} = F_2 + (F_1-1)/G_2 = 1.256$, we obtain a lower noise factor when we first use device 2 in the cascade. The result is F = 0.989dB and G = 19.8dB

6. a) The match for maximum gain is available only if the transistor is unconditionally stable.
$|S_{11}| = 0.668 < 1$; $|S_{22}| = 0.514 < 1$; $K = 1.052 > 1$; $|\Delta| = |(-0.229) + j\cdot(0.205)| = 0.308 < 1$
b) $B_1 = 1.087$; $C_1 = (-0.522) + j\cdot(-0.139)$; $\Gamma_S = (-0.866) + j\cdot(0.230) = 0.896\angle 165.1°$
$B_2 = 0.723$; $C_2 = (-0.153) + j\cdot(-0.322)$; $\Gamma_L = (-0.363) + j\cdot(0.765) = 0.847\angle 115.4°$
c) towards the source: $\theta_{s1} = 174.3°$; $\theta_{p1} = 103.9°$ **or** $\theta_{s2} = 20.6°$; $\theta_{p2} = 76.1°$
toward the load: $\theta_{s1} = 16.3°$; $\theta_{p1} = 107.4°$ **or** $\theta_{s2} = 48.4°$; $\theta_{p2} = 72.6°$

Subject no. 46

1. $Z = 48.00 + j\cdot(-49.64)$; $\Gamma = (Z - Z_0)/(Z + Z_0) = 0.188 + j\cdot(-0.411) = 0.452\angle -65.4°$, plot point in complex plane either with rectangular coordinates or polar coordinates

2. $y = 0.815 - j\cdot 1.040$; $Z = Z_0 / (0.815 - j\cdot 1.040) = 23.341\Omega + j\cdot(29.7853)\Omega$

3. a) Pin = 3.30mW = 5.185dBm; Pc = 5.185dBm - 4.55dB = 0.635 dBm = 1.1575mW
Ideal lossless coupler: P_T = 3.30mW – 1.1575mW = 2.1425 mW= 3.309 dBm ; after amplifier G_1 we have $P_{A1} = P_T + G_1$ = 3.309 dBm + 8.4dB = 11.709 dBm ; inside the filter passband maximum attenuation introduced by the filter is equal to the ripple, $P_{out,max} = P_{A1}$ = 11.709 dBm = 14.82mW, $P_{out,min} = P_{A1} - R$ = 11.709 dBm – 1.2dB = 10.509 dBm = 11.244 mW
b) $P_{meas} = P_C + G_2$ = 0.635 dBm + 9.1dB = 9.735 dBm = 9.408 mW
c) Outside the passband $P_{out} = P_{A1} - A$ = 11.709 dBm – 19.3dB = -7.591 dBm = 0.174 mW

4. $\Gamma = (Z - Z_0)/(Z + Z_0) = -0.057 + j\cdot(-0.414) = 0.418\angle -97.903°$;
b) Complex calculus from L7/L8, 2 solutions for the match, $Z_0 = 50\Omega$ lines
$\theta_{S1} = 106.3°$; $Im(y_S) = -0.920$; $\theta_{p1} = 137.4°$ **and** $\theta_{S2} = 171.6°$; $Im(y_S) = 0.920$; $\theta_{p2} = 42.6°$
c) Obviously the shunt stub θ_p is towards the 50 ohm source

5. In any order we cascade the two devices the gain will be the same $G = G_1 + G_2$ = 9.8dB + 10.0dB = 19.8dB. The "best" placement for the two devices refers to the minimum noise factor.
F_1 = 1.16dB=1.306, F_2 = 0.93dB=1.239, G_1 = 9.8dB = 9.550, G_2 = 10.0dB = 10.000
We compute $F_{12} = F_1 + (F_2-1)/G_1 = 1.331$ and $F_{21} = F_2 + (F_1-1)/G_2 = 1.269$, we obtain a lower noise factor when we first use device 2 in the cascade. The result is F = 1.036dB and G = 19.8dB

6. a) The match for maximum gain is available only if the transistor is unconditionally stable.
$|S_{11}| = 0.606 < 1$; $|S_{22}| = 0.558 < 1$; $K = 1.199 > 1$; $|\Delta| = |(0.232) + j\cdot(-0.076)| = 0.244 < 1$
b) $B_1 = 0.996$; $C_1 = (-0.209) + j\cdot(0.440)$; $\Gamma_S = (-0.346) + j\cdot(-0.729) = 0.807\angle -115.4°$
$B_2 = 0.884$; $C_2 = (-0.428) + j\cdot(-0.039)$; $\Gamma_L = (-0.782) + j\cdot(0.071) = 0.785\angle 174.8°$
c) towards the source: $\theta_{s1} = 129.6°$; $\theta_{p1} = 110.1°$ **or** $\theta_{s2} = 165.8°$; $\theta_{p2} = 69.9°$
toward the load: $\theta_{s1} = 163.4°$; $\theta_{p1} = 111.5°$ **or** $\theta_{s2} = 21.7°$; $\theta_{p2} = 68.5°$

Subject no. 47

1. $Z = 28.26 + j\cdot(-24.21)$; $\Gamma = (Z - Z_0)/(Z + Z_0) = -0.166 + j\cdot(-0.361) = 0.397\angle{-114.7°}$, plot point in complex plane either with rectangular coordinates or polar coordinates

2. $y = 0.930 - j\cdot 1.070$; $Z = Z_0 / (0.930 - j\cdot 1.070) = 23.137\Omega + j\cdot(26.6196)\Omega$

3. a) Pin = 2.35mW = 3.711dBm; Pc = 3.711dBm - 5.65dB = -1.939 dBm = 0.6398mW
Ideal lossless coupler: P_T = 2.35mW – 0.6398mW = 1.7102 mW= 2.330 dBm ; after amplifier G_1 we have $P_{A1} = P_T + G_1$ = 2.330 dBm + 7.1dB = 9.430 dBm ; inside the filter passband maximum attenuation introduced by the filter is equal to the ripple, $P_{out,max} = P_{A1}$ = 9.430 dBm = 8.77mW, $P_{out,min} = P_{A1} - R$ = 9.430 dBm – 1.5dB = 7.930 dBm = 6.209 mW
b) $P_{meas} = P_C + G_2$ = -1.939 dBm + 9.9dB = 7.961 dBm = 6.253 mW
c) Outside the passband $P_{out} = P_{A1} - A$ = 9.430 dBm – 21.6dB = -12.170 dBm = 0.061 mW

4. $\Gamma = (Z - Z_0)/(Z + Z_0) = 0.290 + j\cdot(-0.531) = 0.605\angle{-61.399°}$;
b) Complex calculus from L7/L8, 2 solutions for the match, $Z_0 = 50\Omega$ lines
$\theta_{S1} = 94.3°$; $Im(y_S) = -1.519$; $\theta_{p1} = 123.4°$ **and** $\theta_{S2} = 147.1°$; $Im(y_S) = 1.519$; $\theta_{p2} = 56.6°$
c) Obviously the shunt stub θ_p is towards the 50 ohm source

5. In any order we cascade the two devices the gain will be the same $G = G_1 + G_2$ = 8.2dB + 10.9dB = 19.1dB. The "best" placement for the two devices refers to the minimum noise factor.
F_1 = 1.19dB=1.315, F_2 = 1.04dB=1.271, G_1 = 8.2dB = 6.607, G_2 = 10.9dB = 12.303
We compute $F_{12} = F_1 + (F_2-1)/G_1 = 1.356$ and $F_{21} = F_2 + (F_1-1)/G_2 = 1.296$, we obtain a lower noise factor when we first use device 2 in the cascade. The result is F = 1.127dB and G = 19.1dB

6. a) The match for maximum gain is available only if the transistor is unconditionally stable.
$|S_{11}| = 0.599 < 1$; $|S_{22}| = 0.520 < 1$; $K = 1.191 > 1$; $|\Delta| = |(-0.015) + j\cdot(0.257)| = 0.258 < 1$
b) $B_1 = 1.022$; $C_1 = (-0.476) + j\cdot(0.142)$; $\Gamma_S = (-0.756) + j\cdot(-0.226) = 0.789\angle{-163.4°}$
$B_2 = 0.845$; $C_2 = (-0.251) + j\cdot(-0.318)$; $\Gamma_L = (-0.464) + j\cdot(0.588) = 0.749\angle{128.3°}$
c) towards the source: $\theta_{s1} = 152.7°$; $\theta_{p1} = 111.3°$ **or** $\theta_{s2} = 10.6°$; $\theta_{p2} = 68.7°$
toward the load: $\theta_{s1} = 5.1°$; $\theta_{p1} = 113.9°$ **or** $\theta_{s2} = 46.6°$; $\theta_{p2} = 66.1°$

Subject no. 48

1. $Z = 40.00 + j\cdot(-52.46)$; $\Gamma = (Z - Z_0)/(Z + Z_0) = 0.171 + j\cdot(-0.483) = 0.513\angle{-70.6°}$, plot point in complex plane either with rectangular coordinates or polar coordinates

2. $y = 1.295 + j\cdot 1.230$; $Z = Z_0 / (1.295 + j\cdot 1.230) = 20.298\Omega + j\cdot(-19.2795)\Omega$

3. a) Pin = 3.05mW = 4.843dBm; Pc = 4.843dBm - 5.45dB = -0.607 dBm = 0.8696mW
Ideal lossless coupler: P_T = 3.05mW – 0.8696mW = 2.1804 mW= 3.385 dBm ; after amplifier G_1 we have $P_{A1} = P_T + G_1$ = 3.385 dBm + 8.6dB = 11.985 dBm ; inside the filter passband maximum attenuation introduced by the filter is equal to the ripple, $P_{out,max} = P_{A1}$ = 11.985 dBm = 15.80mW, $P_{out,min} = P_{A1} - R$ = 11.985 dBm – 1.2dB = 10.785 dBm = 11.982 mW
b) $P_{meas} = P_C + G_2$ = -0.607 dBm + 8.7dB = 8.093 dBm = 6.446 mW
c) Outside the passband $P_{out} = P_{A1} - A$ = 11.985 dBm – 22.2dB = -10.215 dBm = 0.095 mW

4. $\Gamma = (Z - Z_0)/(Z + Z_0) = 0.214 + j\cdot(0.202) = 0.294\angle 43.374°$;
b) Complex calculus from L7/L8, 2 solutions for the match, $Z_0 = 50\Omega$ lines
$\theta_{S1} = 31.9°$; $Im(y_S) = -0.615$; $\theta_{p1} = 148.4°$ **and** $\theta_{S2} = 104.8°$; $Im(y_S) = 0.615$; $\theta_{p2} = 31.6°$
c) Obviously the shunt stub θ_p is towards the 50 ohm source

5. In any order we cascade the two devices the gain will be the same $G = G_1 + G_2$ = 9.4dB + 11.0dB = 20.4dB. The "best" placement for the two devices refers to the minimum noise factor.
F_1 = 1.13dB=1.297, F_2 = 0.93dB=1.239, G_1 = 9.4dB = 8.710, G_2 = 11.0dB = 12.589
We compute $F_{12} = F_1 + (F_2 - 1)/G_1 = 1.325$ and $F_{21} = F_2 + (F_1 - 1)/G_2 = 1.262$, we obtain a lower noise factor when we first use device 2 in the cascade. The result is F = 1.012dB and G = 20.4dB

6. a) The match for maximum gain is available only if the transistor is unconditionally stable.
$|S_{11}| = 0.632 < 1$; $|S_{22}| = 0.550 < 1$; $K = 1.223 > 1$; $|\Delta| = |(0.261) + j\cdot(0.003)| = 0.261 < 1$
b) $B_1 = 1.029$; $C_1 = (-0.311) + j\cdot(0.396)$; $\Gamma_S = (-0.502) + j\cdot(-0.639) = 0.813\angle{-128.1°}$
$B_2 = 0.835$; $C_2 = (-0.393) + j\cdot(-0.094)$; $\Gamma_L = (-0.752) + j\cdot(0.181) = 0.773\angle 166.5°$
c) towards the source: $\theta_{s1} = 136.2°$; $\theta_{p1} = 109.7°$ **or** $\theta_{s2} = 171.9°$; $\theta_{p2} = 70.3°$
toward the load: $\theta_{s1} = 167.1°$; $\theta_{p1} = 112.3°$ **or** $\theta_{s2} = 26.4°$; $\theta_{p2} = 67.7°$

Subject no. 49

1. $Z = 29.17+ j\cdot(-17.77)$; $\Gamma = (Z - Z_0)/(Z + Z_0) = -0.202+ j\cdot(-0.270) = 0.337\angle -126.9°$, plot point in complex plane either with rectangular coordinates or polar coordinates

2. $y = 0.765 + j\cdot 1.135$; $Z = Z_0 / (0.765 + j\cdot 1.135) = 20.417\Omega + j\cdot(-30.2917)\Omega$

3. a) Pin = 1.85mW = 2.672dBm; Pc = 2.672dBm - 4.35dB = -1.678 dBm = 0.6795mW
Ideal lossless coupler: P_T = 1.85mW – 0.6795mW = 1.1705 mW= 0.684 dBm ; after amplifier G_1 we have $P_{A1} = P_T + G_1$ = 0.684 dBm + 7.3dB = 7.984 dBm ; inside the filter passband maximum attenuation introduced by the filter is equal to the ripple, $P_{out,max} = P_{A1}$ = 7.984 dBm = 6.29mW, $P_{out,min} = P_{A1} - R$ = 7.984 dBm – 2.9dB = 5.084 dBm = 3.224 mW
b) $P_{meas} = P_C + G_2$ = -1.678 dBm + 11.6dB = 9.922 dBm = 9.821 mW
c) Outside the passband $P_{out} = P_{A1} - A$ = 7.984 dBm – 19.4dB = -11.416 dBm = 0.072 mW

4. $\Gamma = (Z - Z_0)/(Z + Z_0) = 0.232 + j\cdot(0.467) = 0.522\angle 63.627°$;
b) Complex calculus from L7/L8, 2 solutions for the match, $Z_0 = 50\Omega$ lines
$\theta_{S1} = 28.9°$; $Im(y_S) = -1.223$; $\theta_{p1} = 129.3°$ **and** $\theta_{S2} = 87.5°$; $Im(y_S) = 1.223$; $\theta_{p2} = 50.7°$
c) Obviously the shunt stub θ_p is towards the 50 ohm source

5. In any order we cascade the two devices the gain will be the same $G = G_1 + G_2$ = 8.2dB + 11.8dB = 20.0dB. The "best" placement for the two devices refers to the minimum noise factor.
F_1 = 1.24dB=1.330, F_2 = 1.03dB=1.268, G_1 = 8.2dB = 6.607, G_2 = 11.8dB = 15.136
We compute $F_{12} = F_1 + (F_2-1)/G_1 = 1.371$ and $F_{21} = F_2 + (F_1-1)/G_2 = 1.289$, we obtain a lower noise factor when we first use device 2 in the cascade. The result is F = 1.104dB and G = 20.0dB

6. a) The match for maximum gain is available only if the transistor is unconditionally stable.
$|S_{11}| = 0.635 < 1$; $|S_{22}| = 0.550 < 1$; $K = 1.209 > 1$; $|\Delta| = |(0.265)+ j\cdot(0.037)| = 0.267 < 1$
b) $B_1 = 1.029$; $C_1 = (-0.335) + j\cdot(0.377)$; $\Gamma_S = (-0.543) + j\cdot(-0.610) = 0.817\angle -131.7°$
$B_2 = 0.828$; $C_2 = (-0.386) + j\cdot(-0.108)$; $\Gamma_L = (-0.748) + j\cdot(0.208) = 0.776\angle 164.4°$
c) towards the source: $\theta_{s1} = 138.2°$; $\theta_{p1} = 109.4°$ **or** $\theta_{s2} = 173.5°$; $\theta_{p2} = 70.6°$
toward the load: $\theta_{s1} = 168.2°$; $\theta_{p1} = 112.1°$ **or** $\theta_{s2} = 27.3°$; $\theta_{p2} = 67.9°$

Subject no. 50

1. $Z = 25.00 + j\cdot(-28.46)$; $\Gamma = (Z - Z_0)/(Z + Z_0) = -0.166 + j\cdot(-0.442) = 0.472\angle -110.5°$, plot point in complex plane either with rectangular coordinates or polar coordinates

2. $y = 0.745 + j\cdot 1.165$; $Z = Z_0 / (0.745 + j\cdot 1.165) = 19.480\Omega + j\cdot(-30.4615)\Omega$

3. a) Pin = 3.95mW = 5.966dBm; Pc = 5.966dBm - 4.65dB = 1.316 dBm = 1.3539mW
Ideal lossless coupler: P_T = 3.95mW – 1.3539mW = 2.5961 mW= 4.143 dBm ; after amplifier G_1 we have $P_{A1} = P_T + G_1$ = 4.143 dBm + 7.4dB = 11.543 dBm ; inside the filter passband maximum attenuation introduced by the filter is equal to the ripple, $P_{out,max} = P_{A1}$ = 11.543 dBm = 14.27mW, $P_{out,min} = P_{A1} - R$ = 11.543 dBm – 2.3dB = 9.243 dBm = 8.401 mW
b) $P_{meas} = P_C + G_2$ = 1.316 dBm + 8.2dB = 9.516 dBm = 8.945 mW
c) Outside the passband $P_{out} = P_{A1} - A$ = 11.543 dBm – 23.7dB = -12.157 dBm = 0.061 mW

4. $\Gamma = (Z - Z_0)/(Z + Z_0) = 0.212 + j\cdot(0.264) = 0.338\angle 51.230°$;
b) Complex calculus from L7/L8, 2 solutions for the match, $Z_0 = 50\Omega$ lines
$\theta_{S1} = 29.3°$; $Im(y_S) = -0.719$; $\theta_{p1} = 144.3°$ **and** $\theta_{S2} = 99.5°$; $Im(y_S) = 0.719$; $\theta_{p2} = 35.7°$
c) Obviously the shunt stub θ_p is towards the 50 ohm source

5. In any order we cascade the two devices the gain will be the same $G = G_1 + G_2$ = 8.4dB + 11.7dB = 20.1dB. The "best" placement for the two devices refers to the minimum noise factor.
F_1 = 1.29dB=1.346, F_2 = 1.04dB=1.271, G_1 = 8.4dB = 6.918, G_2 = 11.7dB = 14.791
We compute $F_{12} = F_1 + (F_2-1)/G_1 = 1.385$ and $F_{21} = F_2 + (F_1-1)/G_2 = 1.294$, we obtain a lower noise factor when we first use device 2 in the cascade. The result is F = 1.119dB and G = 20.1dB

6. a) The match for maximum gain is available only if the transistor is unconditionally stable.
$|S_{11}| = 0.614 < 1$; $|S_{22}| = 0.520 < 1$; $K = 1.136 > 1$; $|\Delta| = |(-0.072) + j\cdot(0.264)| = 0.274 < 1$
b) $B_1 = 1.031$; $C_1 = (-0.499) + j\cdot(0.084)$; $\Gamma_S = (-0.808) + j\cdot(-0.136) = 0.819\angle -170.5°$
$B_2 = 0.818$; $C_2 = (-0.229) + j\cdot(-0.324)$; $\Gamma_L = (-0.448) + j\cdot(0.634) = 0.777\angle 125.2°$
c) towards the source: $\theta_{s1} = 157.7°$; $\theta_{p1} = 109.3°$ **or** $\theta_{s2} = 12.7°$; $\theta_{p2} = 70.7°$
toward the load: $\theta_{s1} = 7.8°$; $\theta_{p1} = 112.1°$ **or** $\theta_{s2} = 46.9°$; $\theta_{p2} = 67.9°$