

Name: _____

Student Number: _____

Do NOT begin until told to do so

Make sure that you have all pages before starting

Open notes

DO ALL WORK ON THE SPACE GIVENDo **NOT** use the back of the pages, do **NOT** turn in extra sheets of work/paper

Multiple-choice answers should be within 5% of correct value

Show all work, even for multiple choice**Circle** the correct answer**ACADEMIC INTEGRITY:**

Students have the responsibility to know and observe the requirements of The UNCC Code of Student Academic Integrity. This code forbids cheating, fabrication or falsification of information, multiple submission of academic work, plagiarism, abuse of academic materials, and complicity in academic dishonesty.

Unless otherwise noted:

 $F\{\}$ denotes Fourier transform $F^{-1}\{\}$ denotes inverse Fourier transform ω denotes frequency in rad/s

* denotes linear convolution

 $x^*(t)$ denotes the conjugate of $x(t)$

Useful constants, etc:

$e \approx 2.72$

$1/e \approx 0.37$

$\sqrt{3} \approx 1.73$

$\sqrt{7} \approx 2.64$

$\ln(2) \approx 0.69$

$\log_{10}(2) \approx 0.30$

$\log_{10}(10) \approx 1.0$

$\log_{10}(e) \approx 0.43$

$\pi \approx 3.14$

$\sqrt{2} \approx 1.41$

$\sqrt{5} \approx 2.22$

$\sqrt{10} \approx 3.16$

$\ln(4) \approx 1.38$ &

$\log_{10}(3) \approx 0.48$ &

$\log_{10}(0.1) \approx -1$

$\cos(\pi/4) \approx 0.71$

$\cos(A) \cos(B) = 0.5 \cos(A - B) + 0.5 \cos(A + B)$

$e^{j\theta} = \cos(\theta) + j \sin(\theta)$

5 Points Each, **Circle** the correct answer

1. An impedance of $1.0 + j 1.0$ ohms is equivalent to an admittance of

- a) $0.5 - j0.5$ b) $0.25 + j 0.5$ c) $0.5 - j 0.25$ d) none above

2. The percentage of incident power delivered to a load with 7 dB return loss is

- a) 20% b) 65% c) 80% d) none above

3. The Smith chart can only be used for transmission lines with 50 ohms impedance.

- a) True b) False

4. The impedance of a 100 ohm, $3/8 \lambda$ length, transmission line terminated by a short circuit is

- a) $-j 100 \Omega$ b) $j 50 \Omega$ c) $j100 \Omega$ d) none above

5 Points each, **Circle** the correct answer

5. If a +3 volt incident pulse travels down a 75 ohm transmission line terminated in 25 ohms, the **magnitude** of the voltage of the reflected pulse will be

- a) 1 V b) 1.5 V c) 2.5 V d) none above

6. In a $Z_0=50$ ohm system, the angle of the reflection coefficient, Γ , of a capacitor with 60 ohm reactance is

- a) -80° b) -90° c) 90° d) none above

7. An amplifier with source and load impedances of Z_0 and with $s_{21} = 10$ has a transducer gain of

- a) 10 dB b) 17 dB c) 20 dB d) none above

8. The return loss of a 10 ohm resistor in a $Z_0=50$ ohm system is

- a) 3.5 dB b) 4.4 dB c) 6 dB d) none above

5 Points each, **Circle** the correct answer

9. A transmission line is measured to have a capacitance of 250 pF/m and inductance of 100 nH/m, the impedance of the line is.

- a) 20 Ω b) 71 Ω c) 140 Ω d) none above

10. A transmission line is measured to have a capacitance of 250 pF/m and inductance of 100 nH/m, the velocity of the line is.

- a) 1.4×10^8 m/s b) 2.0×10^8 m/s c) 2.5×10^8 m/s d) none above

11. The transducer gain for a 2-port with $\Gamma_S=0$, $\Gamma_L=0.5$, and with $\begin{bmatrix} s_{11} & s_{12} \\ s_{21} & s_{22} \end{bmatrix} = \begin{bmatrix} 0.5 & 0 \\ 10 & 0.5 \end{bmatrix}$ is

- a) 11.2 dB b) 13.6 dB c) 21.2 dB d) none above

12. The cascade noise figure of a 6 dB attenuator followed by an amplifier with 6 dB noise figure and 22 dB gain is:

- a) 6dB b) 12 dB c) 34 dB d) none above

5 Points each, **Circle** the correct answer

13. A 8 dBv signal in 50 ohms is

- a) 11 dBm b) 21 dBm c) 27 dBm d) none above

14. The output noise in a 10 MHz bandwidth at the output of an amplifier with 14 dB gain, and 3 dB noise figure is

- a) -87 dBm b) -103 dBm c) -154 dBm d) none above

15. The effective dielectric constant of a 1.5 mm wide microstrip line on a dielectric with a thickness of 1 mm and dielectric constant 4.8 is

- a) 3.0 b) 3.5 c) 4.8 d) none above

16. The input reflection coefficient, Γ_{IN} , of a 2-port terminated with $\Gamma_L=0.5$, and with

$$\begin{bmatrix} s_{11} & s_{12} \\ s_{21} & s_{22} \end{bmatrix} = \begin{bmatrix} 0 & 0.1 \\ 10 & 0.5 \end{bmatrix} \text{ is}$$

- a) 0 b) 0.38 c) 0.67 d) none above

5 Points each, **Circle** the correct answer

For the following questions, assume $Z_0=50$ ohms, and use the Smith chart and select the closest answer.

17. For $Z= 100 - j50$, $|\Gamma| =$

- a) .25 b) .35 c) .45 d) .71

18. For $Z= 100 - j50$, $\angle \Gamma =$

- a) 83° b) -26° c) 36° d) 135°

19. For $Z= 100 - j50$, assuming the device is a 1-port, $|S_{11}| =$

- a) .14 b) .38 c) .45 d) .71

20. For $Z= 100 - j50$, $Y_n =$

- a) $0.4 + j 0.2$ b) $0.5 - j2$ c) $0.8 + j.4$ d) $0.4 - j0.8$

21. For $Z= 100 - j50$, return loss =

- a) 3 dB b) 5.1 dB c) 7.0 dB d) 14 dB

25 Points , **Circle** the correct answer

22. Three devices are cascaded in a system. Fill in the cascade analysis table as shown in class.

NOTE: the analysis for IP3 and P1dB are OUTPUT IP3 and OUTPUT P1dB of the stages and cascades!!!

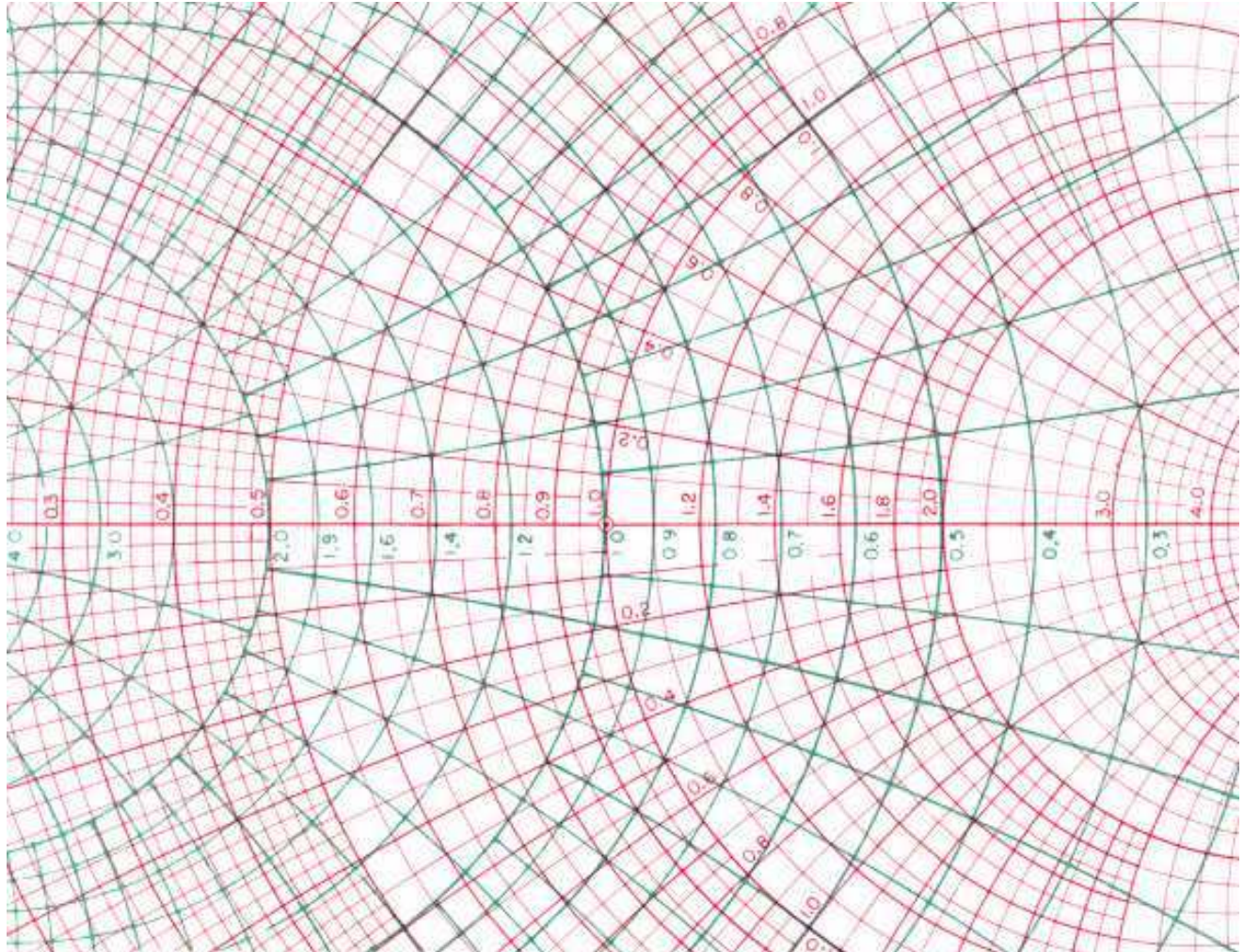
STAGE	Filter	Amp1	Amp2	
gain,dB	-7.0	17.0	10.0	G
nf,dB	7.0	3.0	16.0	NF
OIP3, dBm	50.0	25.0	35.0	OIP3
Output P1dB, dBm	50.0	15.0	20.0	P1dB
TOTAL				
gain,dB	-7.0			G
nf,dB	7.0			NF
OIP3,dBm	50.0			IP3
P1dB out, dBm	50.0			1dB

5 Points Each, **Circle** the correct answer

On the Smith chart below, **assume $Z_0=50$ ohm.**

23. Show the location of $Z=60 + j 10$ ohms as an "X" on the Smith chart below.

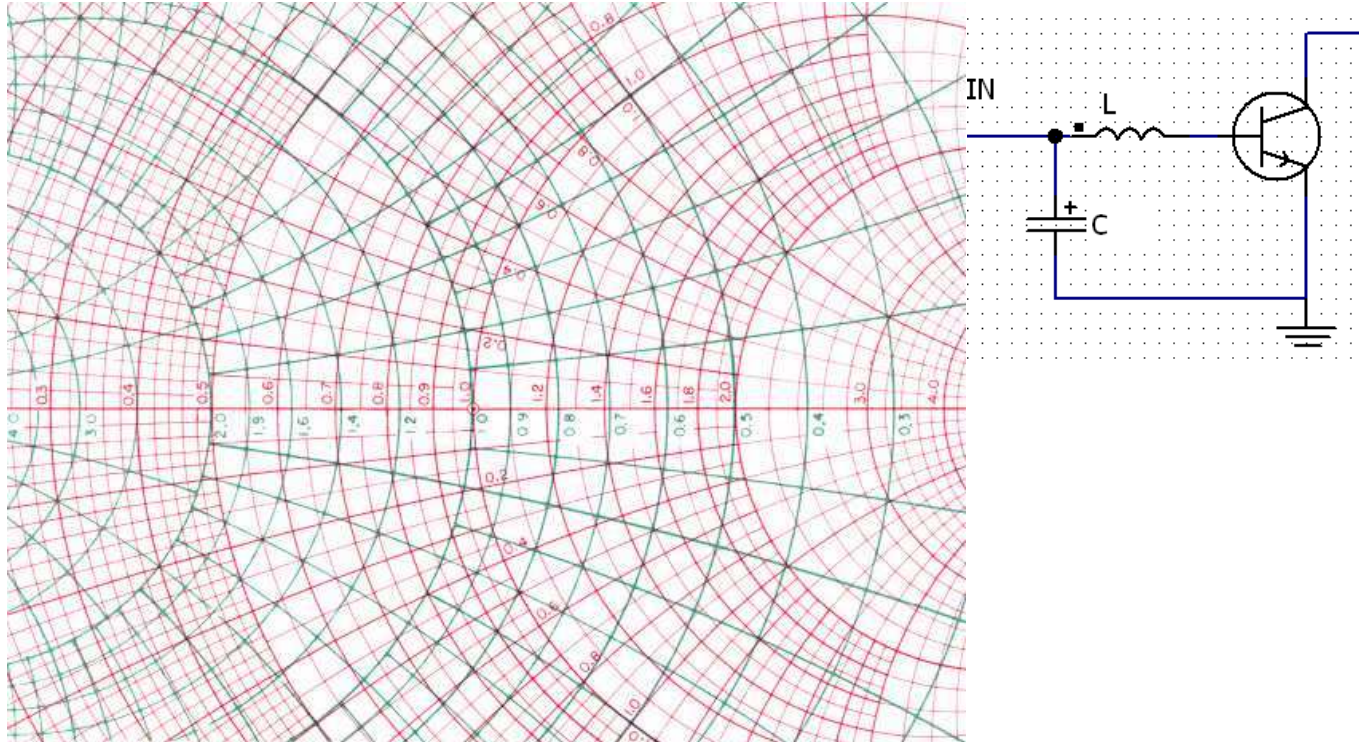
24. Show the location of $Y = 0.06$ siemens as an "O" on the Smith chart below.



On the Smith chart below, assume $Z_0=50$ ohm.

25. (10 Points)

Draw the paths (for L and C) on the Smith chart below corresponding to the matching network of the circuit shown below. The circuit matches the $15 - j5$ ohm transistor input impedance into **50** ohms.



5 Points each

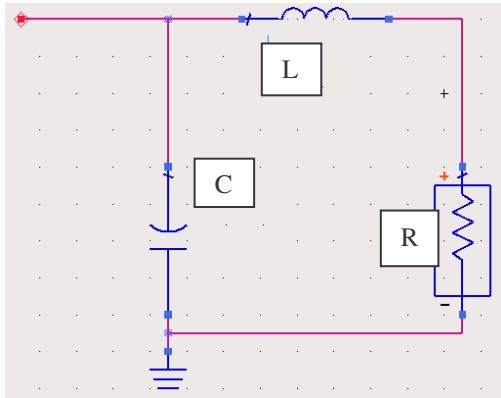
26. In the above circuit, the Normalized impedance of the inductor (to within 10%) in the matching circuit $Z_n =$

- a) $j 0.22$ b) $j 0.56$ c) $j 0.76$ d) $0.5 + j 0.5$

27. In the above circuit, the Normalized Admittance of the capacitor (to within 10%) in the matching circuit $Y_n =$

- a) $j 0.5$ b) $-j 0.65$ c) $j 0.8$ d) $j 1.5$

In the circuit below, the normalized impedance of the inductor L is $Z_n = j 2.5$, and the normalized admittance of the capacitor C is $Y_n = j 1.5$, where $Z_0=50$ ohms. The frequency is 1000 MHz.



5 Points Each, **Circle** the correct answer

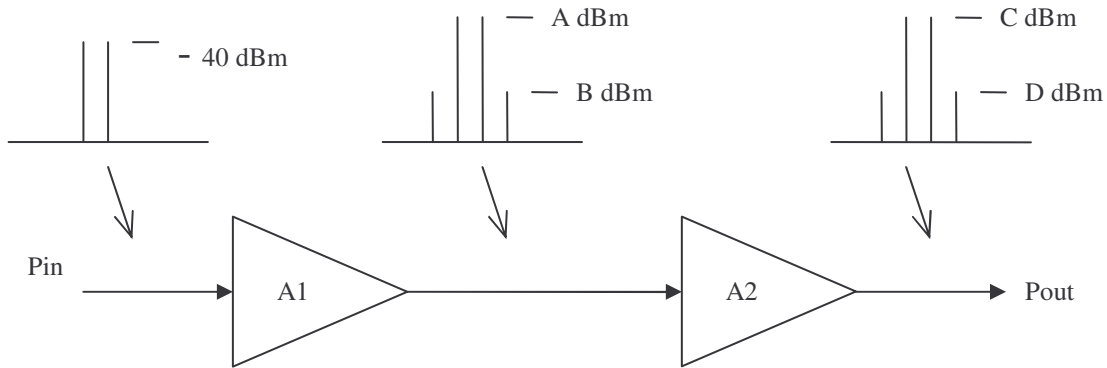
28. In the above circuit, the value the capacitor (within 10%) in the matching circuit is

- a) 0.16 pF b) 1.6 pF c) 4.8 pF d) none above

29. In the above circuit, the value the inductor (within 10%) in the matching circuit is

- a) 20 nH b) 19.9 nH c) 3.8 nH d) none above

The following linear output power and third-order distortion spectra through two amplifiers. Amplifier A1 has gain $G_1=23$ dB and $OIP3_1=3$ dBm. Amplifier A2 has gain $G_2=17$ dB and $OIP3_2=40$ dBm.



5 Points Each, **Circle** the correct answer

30. In the spectrum of the output of A1, signal level A =

- a) -30 dBm b) -20 dBm c) -17 dBm d) none above

31. In the spectrum of the output of A1, signal level B =

- a) -73 dBm b) -67 dBm c) -23 dBm d) none above

32. In the spectrum of the output of A2, signal level C =

- a) -30 dBm b) 0 dBm c) 10 dBm d) none above

33. In the spectrum of the output of A2, signal level D =

- a) -50 dBm b) -40 dBm c) -36 dBm d) none above