

Name: _____

Last 4 digits of Student Number: _____

Do NOT begin until told to do so

Make sure that you have all pages before starting

Open book, open notes, you may use excel spreadsheet from course website

DO ALL WORK ON THE SPACE GIVEN

Do **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:

$$e \approx 2.72$$

$$1/e \approx 0.37$$

$$\sqrt{3} \approx 1.73$$

$$\sqrt{7} \approx 2.64$$

$$\ln(2) \approx 0.69$$

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

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

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

$$\pi \approx 3.14$$

$$\sqrt{2} \approx 1.41$$

$$\sqrt{5} \approx 2.22$$

$$\sqrt{10} \approx 3.16$$

$$\ln(4) \approx 1.38 \text{ \&}$$

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

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

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

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

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

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

1. An impedance of $1.0 + j 2.0$ ohms is equivalent to an admittance of

- a) $0.2 - j0.4$ b) $0.2 + j 0.4$ c) $0.4 - j 0.2$ d) none above

2. The percentage of incident power delivered to a load with 1 dB return loss is

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

3. A power level of 5 mW is equivalent to

- a) -5 dBm b) 2 dBm c) 7 dBm d) none above

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

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

5. The impedance of a 100 ohm, $1/4 \lambda$ long, transmission line terminated by 200 ohms is

- a) 50Ω b) 100Ω c) 200Ω d) none above

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

6. If a +3 volt incident pulse travels down a 50 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

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 100 ohm resistor in a $Z_0=50$ ohm system is

- a) 3.5 dB b) 4.4 dB c) 9.5 dB d) none above

9. The transducer gain for a 2-port with $\Gamma_S=0$, $\Gamma_L=0.5$, and with $\begin{bmatrix} s_{11} & s_{12} \\ s_{21} & s_{22} \end{bmatrix} = \begin{bmatrix} 0.5 & 0.1 \\ 7 & 0.5 \end{bmatrix}$ is

- a) 8.5 dB b) 16.1 dB c) 18.2 dB d) none above

10. A transmission line is measured to have a capacitance of 500 pF/m and inductance of 200 nH/m, the impedance of the line is.

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

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

11. The output noise in a 10 MHz bandwidth at the output of an amplifier with 10 dB gain, and 4 dB noise figure is

- a) -77 dBm b) -90 dBm c) -121 dBm d) none above

12. The effective dielectric constant of a 2.5 mm wide microstrip line on a dielectric with a thickness of 5 mm and dielectric constant 4.8 is

- a) 3.3 b) 3.6 c) 4.8 d) none above

13. The impedance of a 2.5 mm wide microstrip line on a dielectric with a thickness of 5 mm and dielectric constant 4.8 is

- a) 33 Ω b) 47 Ω c) 92 Ω d) none above

14. For $Z = 100 - j100$ in a 50 ohm system, return loss =

- a) 3.2 dB b) 4.1 dB c) 7.3 dB d) 14 dB

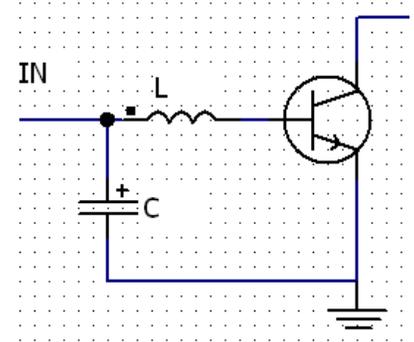
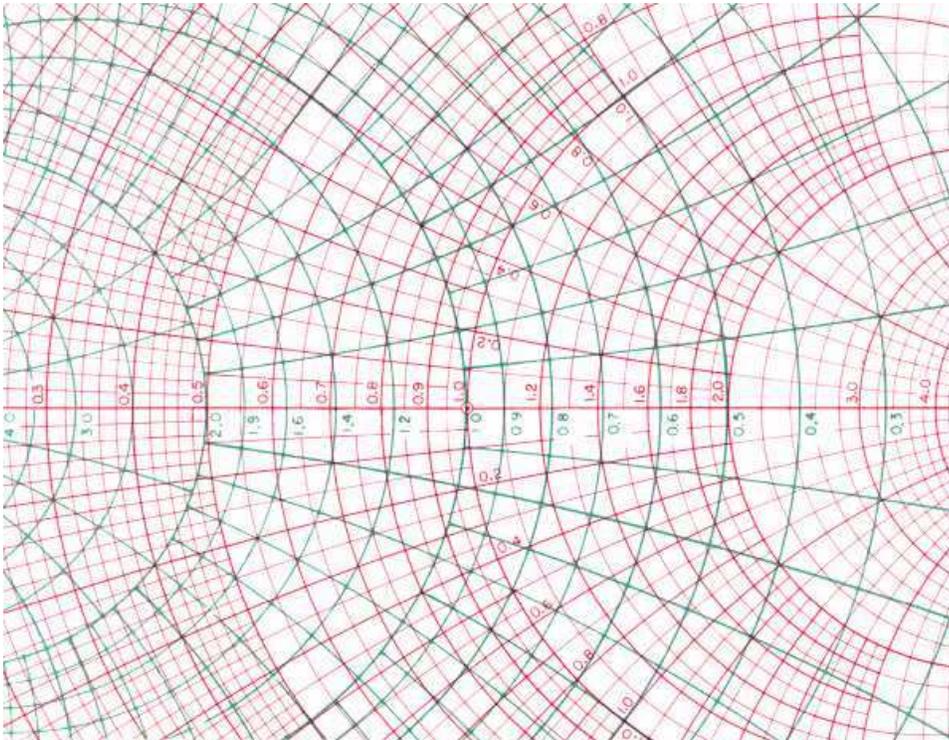
15. For $Z = 100 - j100$ in a 50 ohm system, $\angle \Gamma =$

- a) -30° b) -46° c) 76° d) 131°

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

16. (10 Points)

Draw the paths on the Smith chart below (for L and C) corresponding to the matching network of the circuit shown below. The circuit matches the $20 + j10$ ohm transistor input impedance into **50** ohms.



5 Points each

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

- a) $j 0.29$ b) $j 0.56$ c) $j 0.76$ d) $0.5 + j 0.5$

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

- a) $j 0.5$ b) $-j 0.5$ c) $j 1.2$ d) $j 1.9$

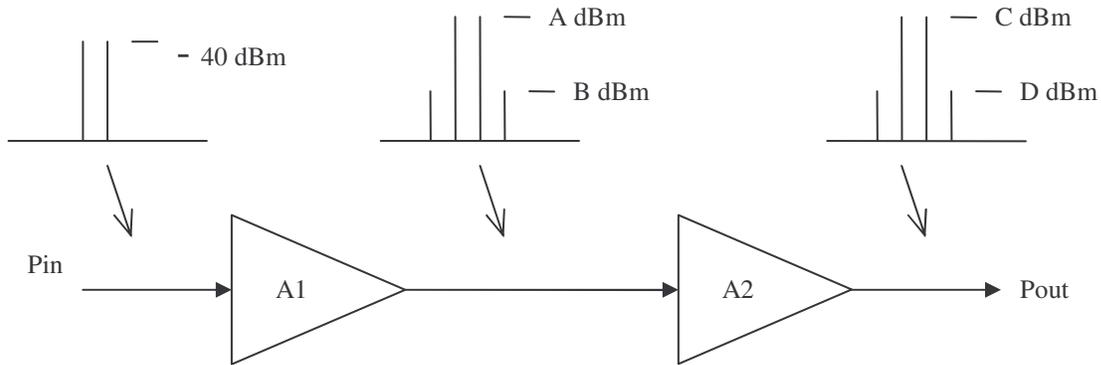
25 Points , **Fill in** the correct answers

19. 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	-5.0		17.0		18.0	G
nf,dB	5.0		2.0		7.0	NF
OIP3, dBm	50.0		25.0		43.0	OIP3
Output P1dB, dBm	50.0		15.0		30.0	P1dB
TOTAL						
gain,dB	-5.0					G
nf,dB	5.0					NF
OIP3,dBm	50.0					IP3
P1dB out, dBm	50.0					1dB

The following linear output power and third-order distortion spectra through two amplifiers. Amplifier A1 has gain $G_1=20$ dB and $OIP3_1=13$ dBm. Amplifier A2 has gain $G_2=30$ dB and $OIP3_2=20$ dBm.



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

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

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

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

- a) -63 dBm b) -77 dBm c) -86 dBm d) none above

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

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

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

- a) -23 dBm b) -10 dBm c) -13 dBm d) none above

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

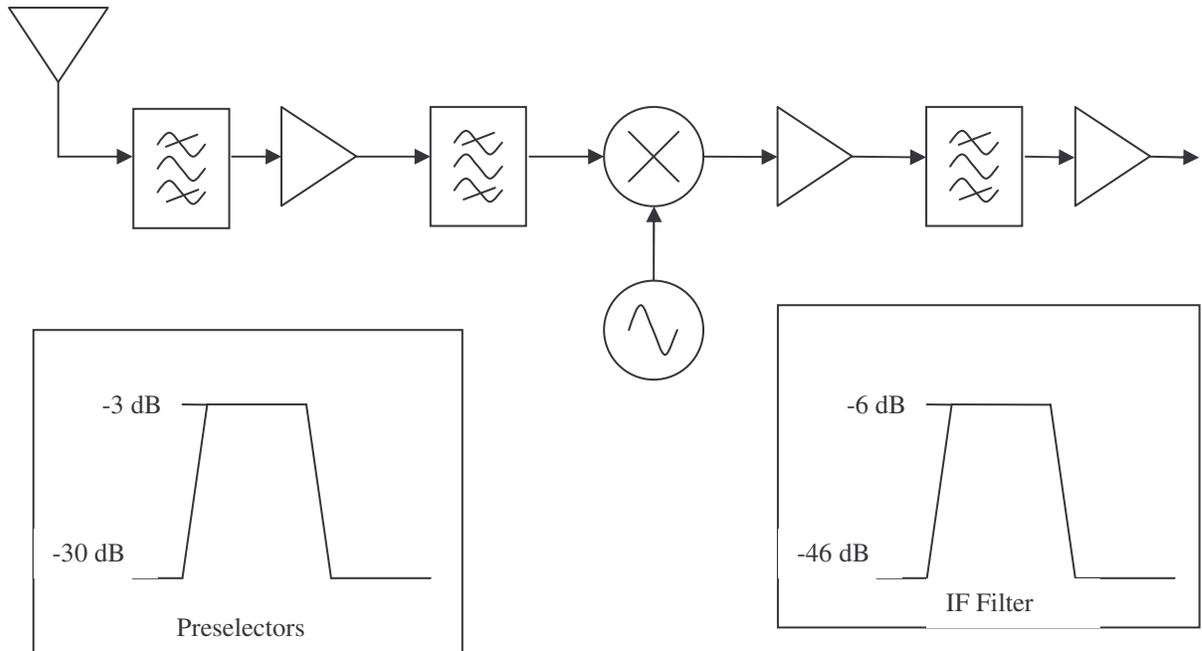
24. The sensitivity of a receiver, assuming 17 dB S/N is required, with 80 dB gain, 10 dB noise figure, 30 dBm output third order intercept, and 5 KHz IF bandwidth is

- a) -83 dBm b) -97 dBm c) -110 dBm d) none above

25. The spur-free dynamic range of a receiver front-end with 70 dB gain, 11 dB noise figure, 10 MHz preselector bandwidth, 30 dBm output third order intercept, and 2 MHz IF bandwidth is

- a) 40 dB b) 62 dB c) 74 dB d) none above

The following questions address the receiver below.



5 Points Each

26. The image rejection of the above receiver is most likely

- a) 33 dB b) 54 dB c) 66 dB d) none above

27. The adjacent channel selectivity of the above receiver is most likely

- a) 46 dB b) 40 dB c) 54 dB d) none above

28. If the radio uses high side injection, the RF is 101.4 MHz, and the IF is 21.4 MHz, the LO frequency must be

- a) 80 MHz b) 101.4 MHz c) 122.8 MHz d) none above