

Name: _____

Student Number: _____

Do NOT begin until told to do so

Make sure that you have all pages before starting

Open notes, NO CELL PHONES/WIRELESS DEVICES

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 and true/false answers should be within 5% of correct value

Show all work, even for multiple choice

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

1. The wavelength in free space at 300 MHz is

- a) 1 m b) 3 m c) 30 cm d) none above

2. The noise figure of a 10 dB attenuator is

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

3. A power of 1 watt in a 50 ohm system is equivalent to

- a) 1 Vrms b) 3 Vrms c) 7 Vrms d) none above

4. The impedance of a 50 ohm, $3/8 \lambda$ length, transmission line terminated by a short circuit is

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

5. The angle of the reflection coefficient, Γ , of a short circuit in a $Z_0=50 \Omega$ system is

- a) 0° b) 90° c) 180° d) none above

5 Points each

6. The 1 dB output compression point (P1dB) of an amplifier is near the power level at which the output of the amplifier begins to clip.

- a) True b) False

7. Adjacent channel rejection is most often established by the IF filter of a radio.

- a) True b) False

8. The preselector determines receiver SFDR (spur free dynamic range).

- a) True b) False

9. In a block converter, the LO frequency is usually variable.

- a) True b) False

10. The first amplifier stage is most critical in establishing receiver noise figure.

- a) True b) False

5 Points each

11. A single-conversion receiver has an LO frequency of 120 MHz, an IF frequency of 10 MHz and high-side injection. The desired RF frequency of the receiver is:

- a) 90 MHz b) 110 MHz c) 130 MHz d) none above

12. A single-conversion receiver has a desired RF frequency of 2110 MHz with an LO frequency of 2100 MHz. The image frequency of the receiver is:

- a) 2090 MHz b) 2100 MHz c) 2110 MHz d) none above

13. A single-conversion receiver has an IF frequency of 30 MHz, desired RF frequency band of 80-100 MHz with high-side injection. The receiver LO frequency is:

- a) 50-70 MHz b) 110-120 MHz c) 110-130 MHz d) none above

14. The output noise power of a receiver with 74 dB gain, 10 dB noise figure, 10 MHz preselector bandwidth, and 1 MHz IF bandwidth is

- a) -30 dBm b) -34 dBm c) -100 dBm d) none above

15. The effective (or equivalent) input noise power of a receiver with 70 dB gain, 14 dB noise figure, and 1 MHz bandwidth is

- a) -70 dBm b) -84 dBm c) -100 dBm d) none above

5 Points each

16. The impedance of a 2 mm wide microstrip line on a printed circuit board of thickness 1 mm and dielectric constant $\epsilon_r = 4.8$ is (to within 5%)

- a) 47 Ω b) 58 Ω c) 74 Ω d) none above

17. The effective dielectric constant of a 1 mm wide microstrip line on a printed circuit board of thickness 2 mm and dielectric constant $\epsilon_r = 4.8$ is (to within 5%)

- a) 2.8 b) 3.3 c) 4.1 d) none above

18. The wavelength of a 300 MHz electromagnetic wave in a transmission line with effective dielectric constant $\epsilon_r = 4$ is (to within 5%)

- a) .5 m b) 1 m c) 2 m d) none above

19. The gain of a half-wave dipole antenna is (to within 0.5 dB)

- a) 0 dBi b) 2 dBi c) 6 dBi d) none above

20. The gain of an antenna becomes larger as the antenna aperture increases.

- a) True b) False

5 Points each

21. The free-space loss between two 3 dBi antennas at 200MHz and separation of 5 km is (to within 2 dB)

- a) 87 dB b) 72 dB c) 60 dB d) none above

22. In an urban environment, signal power between antennas would decrease by 9 dB with each doubling in antenna separation for parameter $n = 4$.

- a) True b) False

23. A 180 degree hybrid can be used to subtract two signals.

- a) True b) False

24. A rat-race coupler is a form of a 90 degree hybrid.

- a) True b) False

25. An 11-stage ring oscillator with propagation delay of 1 ns would oscillate at a frequency of:

- a) 22 MHz b) 45 MHz c) 90 MHz d) none above

5 Points each

26. A circulator can be used to couple a receiver and transmitter to an antenna.

- a) True b) False

27. A duplexer can be used to couple a receiver and transmitter to an antenna.

- a) True b) False

28. The sensitivity of a receiver, assuming 20 dB S/N is required, with 70 dB gain, 14 dB noise figure, 30 dBm output third order intercept, and 1 KHz IF bandwidth is

- a) -80 dBm b) -90 dBm c) -110 dBm d) none above

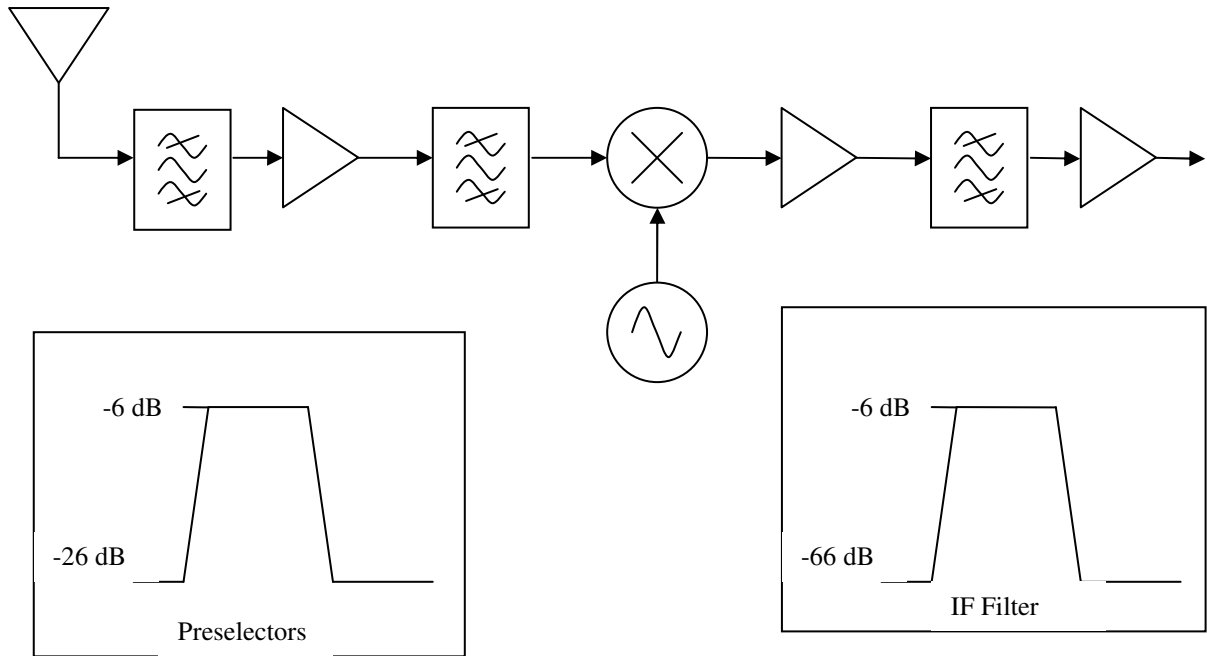
29. The spur-free dynamic range of a receiver front-end with 40 dB gain, 14 dB noise figure, 10 MHz preselector bandwidth, 30 dBm output third order intercept, and 1 MHz IF bandwidth is

- a) 40 dB b) 60 dB c) 70 dB d) none above

30. For an amplifier with third order output intercept of 20 dBm, when the two-tone output power level is 0 dBm, the power level of the third-order distortion products at the output is

- a) -30 dBm b) -40 dBm c) -50 dBm d) none above

The following questions address the receiver below.



5 Points Each

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

- a) 40 dB b) 68 dB c) 80 dB d) none above

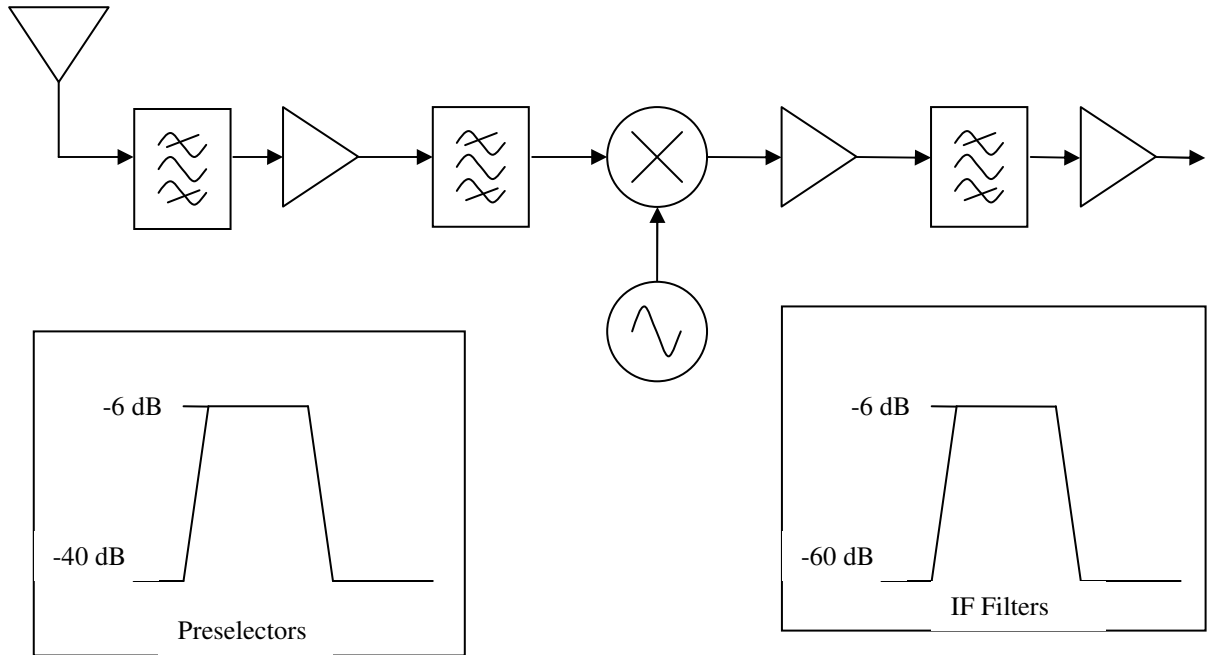
32. The adjacent channel selectivity of the above receiver is most likely

- a) 34 dB b) 54 dB c) 60 dB d) none above

33. The noise figure of the above receiver could possibly be 5 dB.

- a) True b) False

The following questions address the receiver below.



5 Points Each

34. If the receive frequency range of the above receiver is 1000 to 1100 MHz, and the IF frequency was 200 MHz, the LO frequency would be

- a) 700-800 MHz b) 1200-1300 MHz c) 1300–1400 MHz d) none above

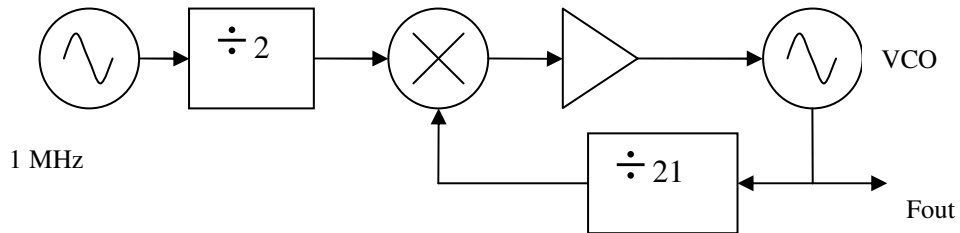
35. If the receive frequency of the above receiver was 1000 MHz, and the LO frequency was 1200 MHz, the image frequency would be

- a) 800 MHz b) 1100 MHz c) 1400 MHz d) none above

36. The IF filter eliminates image problems.

- a) True b) False

The following questions address the frequency synthesizer below.



5 Points Each

37. The output frequency F_{out} is

- a) 2.1 MHz b) 10.5MHz c) 21 MHz d) none above

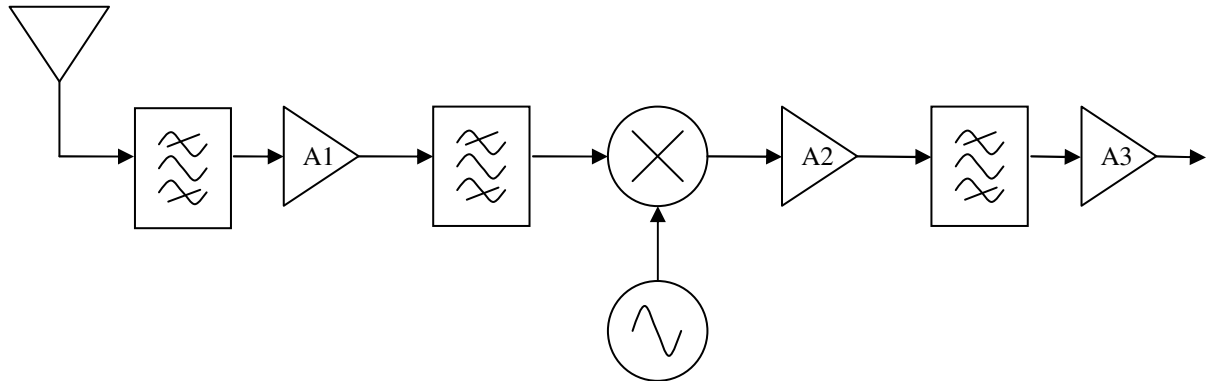
38. The frequency step size for the above frequency synthesizer is

- a) 0.2 MHz b) 0.5 Mhz c) 1 MHz d) none above

39. If the feedback divider is changed from 21 to 20, then output frequency F_{out} becomes

- a) 10 MHz b) 20 MHz c) 21 MHz d) none above

The following 1.9 GHz receiver has a 200 MHz IF, and all filter insertion losses may be assumed to be 3 dB.



MODEL NO.	FREQ. ⚡ (MHz)	GAIN (dB) Typical at MHz			Note 1 Min.	MAXIMUM POWER (dBm)		DYNAMIC RANGE		VSWR (:1) Typ.	
		100	1000	2000		Output (1 dB Comp.) Typ.	Input (no damage)	NF (dB) Typ.	IP3 (dBm) Typ.	In	Out
MAR-1SM	DC-1000	18.5	15.5	—	13.0	+1.5	+13	5.5	+14.0	1.3	1.2
MAR-2SM	DC-2000	12.5	12.0	11.0	8.5	+4.5	+13	6.5	+17.0	1.5	1.4
MAR-3SM	DC-2000	12.5	12.0	10.5	8.0	+10.0	+13	6.0	+23.0	1.5	1.7
MAR-4SM	DC-1000	8.3	8.0	—	7.0	+12.5	+13	7.0	+25.5	1.5	1.9
MAR-6SM	DC-2000	20.0	16.0	11.0	9.0	+2.0	+13	3.0	+14.5	1.7	1.7
MAR-7SM	DC-2000	13.5	12.5	11.0	8.5	+5.5	+13	5.0	+19.0	1.7	1.7
/ MAR-8ASM	DC-1000	31.5	25	—	20.0	+12.5	+13	3.1	+25.0	1.4	1.8
MAR-8SM	DC-1000	32.5	22.5	—	19.0	+12.5	+13	3.3	+27.0	#	#

5 Points Each

40. The best amplifier for A1 would be

- a) MAR-1SM b) MAR-2SM c) MAR-4SM d) MAR-6SM

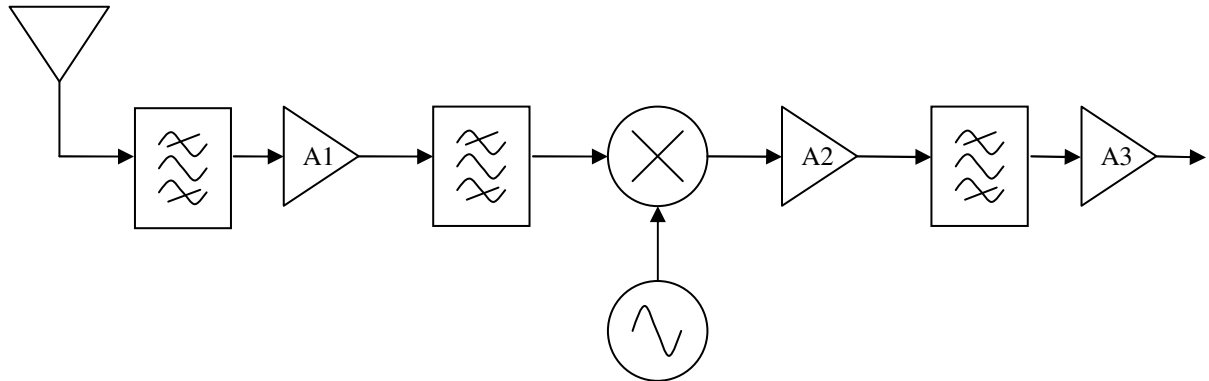
41. If A1 was a MAR-2SM, the front-end noise figure up to the output of the second preselector filter would be

- a) 3 dB b) 9.5 dB c) 12.5 dB d) none above

42. If A1 was a MAR-2SM, the 1 dB output compression point up to the output of the second preselector filter would be

- a) 1.5 dB b) 4.5 dB c) 8.5 dB d) none above

The following 1.9 GHz receiver has a 200 MHz IF, and all filter insertion losses may be assumed to be 3 dB.



+7 dBm LO, up to +1 dBm RF

ADE/ADEX

MODEL NO.	FREQUENCY MHz		CONVERSION LOSS dB				LO-RF ISOLATION dB						LO-IF ISOLATION dB						IP3@ center band Typ. (dBm)
	LO/RF f_l-f_u	IF	Mid-Band			Total Range Max.	L		M		U		L		M		U		
			σ	Max.	Max.		Typ. Min.	Typ. Min.	Typ. Min.	Typ. Min.	Typ. Min.	Typ. Min.	Typ. Min.	Typ. Min.					
ADE-1**	0.5-500	DC-500	5.0	.10	6.5	7.8	70	50	55	35	45	30	65	45	40	25	30	20	15
ADE-1ASK**	2-600	DC-600	5.3	.10	6.5	7.5	55	45	50	30	40	25	50	40	45	24	35	18	16
ADE-2ASK**	1-1000	DC-1000	5.4	.10	6.8	9.5	55	45	45	30	36	20	50	40	32	22	22	12	12
ADE-2	5-1000	DC-1000	6.67	0.26	8.0	9.5	60	40	47	25	32	22	62	35	45	25	32	20	20
ADE-3G**	2300-2700	DC-400	5.6	.10	—	7.0	36 (typ.) 25 (min.)			26 (typ.) 17 (min.)						13			
ADE-3GL**	2100-2600	DC-600	6.0	.25	—	8.8	34 (typ.) 25 (min.)			20 (typ.) 7 (min.)						17			
ADE-4**	200-1000	DC-800	6.8	.10	8.5	8.5	60	45	53	40	45	30	45	30	40	22	35	20	15
ADE-5**	5-1500	DC-1000	6.6	.10	7.5	9.3	50	40	40	25	33	23	50	40	30	20	20	10	15
ADE-6**	0.05-250	DC-200	4.6	.05	7.0	8.4	62	49	40	30	40	20	58	44	45	24	25	15	10
ADE-11X**	10-2000	5-1000	7.1	.10	8.2	9.8	62	45	36	20	27	18	60	45	37	20	38	20	9

5 Points Each

43. The best mixer for the receiver would be

- a) ADE-1ASK b) ADE-4ASK c) ADE-3GL d) ADE-11X

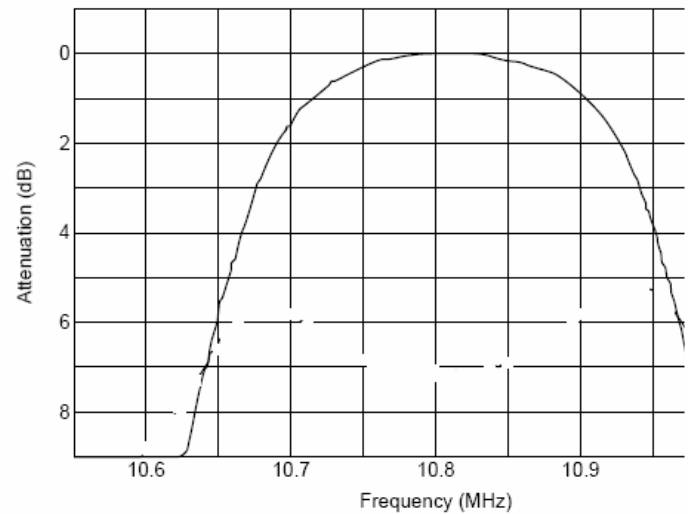
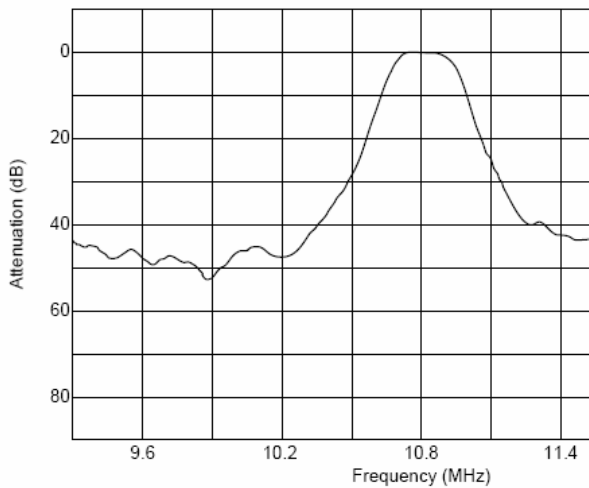
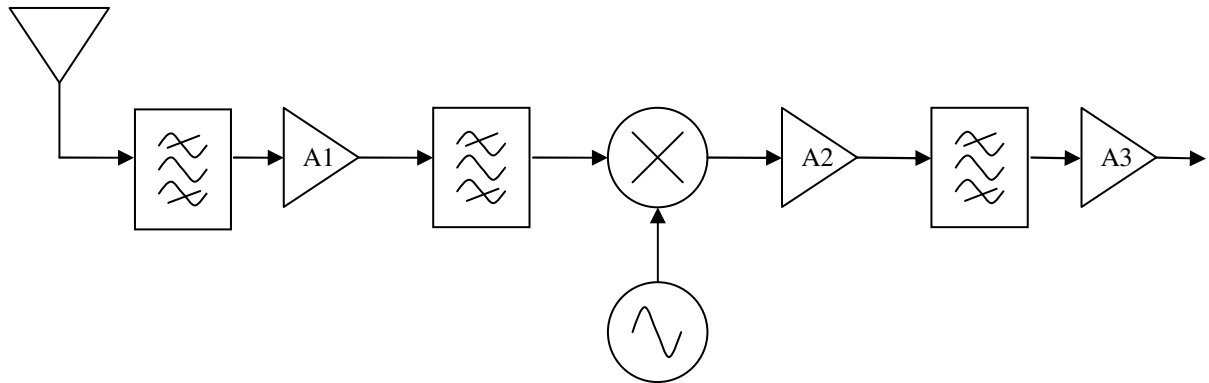
44. The output 1 dB compression point of the ADE-1ASK at mid-band is most nearly

- a) -5.3 dBm b) 4.3 dBm c) 7 dBm d) 16 dBm

45. The best LO frequency is

- a) 200 MHz b) 1700 MHz c) 1900 MHz d) 2000 MHz

The following 800 MHz receiver has the following IF filter and 250 KHz channel spacing.



5 Points Each

46. The 3 dB bandwidth of the receiver is most nearly

- a) 100 KHz b) 250 KHz c) 10.8 MHz d) 10.9 MHz

47. The alternate channel selectivity of the receiver is most nearly

- a) 20 dB b) 25 dB c) 45 dB d) 60 dB

48. The best LO frequency is

- a) 10.8 MHz b) 800 MHz c) 810.8 MHz d) 820 MHz