**Q.2 a. Define modulation and discuss the need for modulation. (5)**

**Answer: Refer page 5 of Text Book**

**b. Define the equivalent noise temperature. Under what conditions could this be a more useful quantity than the noise figure? (5)**

**Answer: Refer page 31 of Text Book**

**c. A receiver connected to an antenna whose resistance is $50\Omega$ has an equivalent noise resistance of $30\Omega$. Calculate the receivers noise figure in decibels and its equivalent noise temperature. (6)**

**Answer:**

$$F = 1 + \frac{R_{eq}}{R_a} = 1 + \frac{30}{50} = 1.6$$

$$= 2.04\,dB$$

$$T_{eq} = T_0(F-1) = 290\,(1.6-1) = 174\,K$$

**Q.3 a. Define Amplitude modulation and modulation index. A certain transmitter radiates 9 KW with the carrier unmodulated, and 10.125 KW when the carrier is sinusoidally modulated. Calculate the modulation index. If another sine wave, corresponding to 40% modulation, is transmitted simultaneously, determine the total radiated power. (10)**

**Answer:**

$$m = \frac{V_m}{V_c} \qquad 0 \le m \le 1$$

$$\frac{m^2}{2} = \frac{P_t}{P_c} - 1 = \frac{10.125}{9} - 1 = 0.125$$

$$\Rightarrow m = 0.5$$

$$m_t = \sqrt{m_1^2 + m_2^2} = \sqrt{.5^2 + .4^2} = .64$$

$$P_t = P_c\left(1 + \frac{m_t^2}{2}\right) = 10.84\,KW$$

 

b. **Provide a comparison between filter system and phase shift method for SSB generation. (6)**

**Answer:** **Refer pages 64 & 65 of Text Book**

**Q.4 a. Out of the various advantages of FM over AM, identify and discuss those due to the intrinsic qualities of FM. (8)**

**Answer:** **Refer page 91 of Text Book**

b. **What is pre-emphasis? Why is it used? Sketch a typical pre-emphasis circuit and explain why must deemphasis also be used? (8)**

**Answer:** **Refer page 95 of Text Book**

**Q.5 a. Define the terms sensitivity, selectivity and image frequency. (6)**

**Answer:** **Refer pages 123, 125, 126 of Text Book**

b. **In a broadcast superheterodyne receiver having no RF amplifier, the loaded Q of the antenna coupling circuit (at the input to the mixer) is 100. If the intermediate frequency is 455kHz, in order to make the image frequency rejection of the receiver as good at 25MHz as it is at 1000 kHz, calculate the loaded Q which an RF amplifier for this receiver would have to have and the new intermediate frequency that would be needed (if there is to be no RF amplifier) (10)**

**Answer:**

$$f_{si}\Big|_{1000kHz} = 1000 + 2\times 455 = 1910\ kHz$$

$$\rho = \frac{1910}{1000} - \frac{1000}{1910} = 1.386$$

$$\alpha = \sqrt{1 + 100^2 \times 1.386^2} = 138.6$$

$$f_{si}\Big|_{25MHz} = 25 + 2\times 0.455 = 25.91\ MHz$$

$$\rho = \frac{25.91}{25} - \frac{25}{25.91} = 0.0715$$

$$\alpha = \sqrt{1 + 100^2 \times .0715^2} = 7.22$$

Since mixer has a rejection of 7.22, image rejection of RF stage will have to be

$$\alpha' = \frac{138.6}{7.22} = 19.2 = \sqrt{1 + Q'^2 \times .0715^2}$$

$$\Rightarrow \boxed{Q' = 268}$$

If rejection is to be the same as initially, though a change in intermediate freq, ρ will have to be same (as at 1000 kHz) since Q is also same.

Thus, $$\frac{f_s'}{f_{si}'} = \frac{1910}{1000} = 1.91$$

$$\frac{25 + 2f_i'}{25} = 1.91 \Rightarrow f_i' = 11.4\,MHz$$

**Q.6 a. Define radiation resistance of an antenna. Calculate the radiation resistance of a $\lambda/16$ wire dipole in free space. (8)**

**Answer: Refer page 264 of Text Book**

$$R_r = 80\pi^2 \left(\frac{l}{\lambda}\right)^2 = 790 \left(\frac{l}{\lambda}\right)^2$$

Here, $\frac{l}{\lambda} = \frac{1}{16} \Rightarrow R_r = \frac{790}{16^2} = 3.086\,\Omega$

**b. What are the four major functions that must be fulfilled by antenna couplers? (8)**

**Answer: Refer page 273 of Text Book**

**Q.7 a. What is fading? List its major causes. (3)**

**Answer: Refer page 244 of Text Book**

**b. Explain what is meant by isotropic source and isotropic medium. (3)**

**Answer: Refer page 225 of Text Book**

**c. A rectangular waveguide measures $3 \times 4.5cm$ internally and has a 9 GHz signal propagated in it. Calculate the cut off wavelength, guide wavelength, group and phase velocities and characteristic wave impedance for $TE_{10}$ and $TM_{11}$ mode. (10)**

**Answer:**

$$\lambda = \frac{v_c}{f} = \frac{3 \times 10^{10}}{9 \times 10^9} = 3.33cm$$

$TE_{10}$) cut off wavelength,

$$\lambda_0 = \frac{2a}{m} = \frac{2 \times 4.5}{1} = 9cm$$

$$p = \sqrt{1 - \left(\frac{\lambda}{\lambda_0}\right)^2} = 0.93$$

guide wavelength

$$\lambda_p = \frac{\lambda}{p} = 3.58 cm$$

group & phase velocity

$$v_g = v_c p = 3 \times 10^8 \times 0.93 = 2.79 \times 10^8 m/s$$

$$v_p = \frac{v_c}{p} = 3.23 \times 10^8 m/s$$

Characteristic wave impedance

$$Z_0 = \frac{L}{p} = \frac{120\pi}{.93} = 405\Omega$$

$TM_{11})$ $\lambda_o = \dfrac{2}{\sqrt{\left(\frac{m}{a}\right)^2 + \left(\frac{n}{b}\right)^2}} = \dfrac{2}{\sqrt{\left(\frac{1}{4.5}\right)^2 + \left(\frac{1}{3}\right)^2}} = 5\text{ cm}$

$$\rho = \sqrt{1 - \left(\frac{3.33}{5}\right)^2} = .746$$

$$\lambda_p = \frac{\lambda}{\rho} = 4.6\text{ cm}$$

$$v_g = v_c \rho = 2.24 \times 10^8 \text{ m/s}$$

$$v_p = \frac{v_c}{\rho} = 4.02 \times 10^8 \text{ m/s}$$

for TM mode, char. wave impedance

$$Z_o = Z\rho = 120\pi \times .745 = 281\,\Omega$$

**Q.8 a. A 2 kHz channel has a SNR of 24 dB. Calculate the maximum capacity of this channel. Assuming constant transmitting power, calculate the maximum capacity when the channel bandwidth is**
**(i) halved and (ii) reduced to a quarter of the original value. (8)**

**Answer: (i)**

$$\frac{S}{N} = \text{antilog}\left(\frac{24}{10}\right) = \text{antilog } 2.4$$

$$C = 2000 \times \log_2\left(1 + \frac{S}{N}\right) = 15{,}957 \text{ b/s}$$

If power transmitted is constt. & BW is halved
⇒ noise power is halved
⇒ SNR is doubled

$$C = \frac{2000}{2} \times \log_2\left(1 + 2 \times \frac{S}{N}\right)$$

$$= 8{,}975 \text{ b/s}$$

**(ii)**

when BW is reduced to 1/4, noise power is reduced by 1/4 & S/N inc 4 times

$\therefore C = \frac{2000}{4} \times \log_2\left(1 + 4 \times \frac{S}{N}\right)$

$= 4{,}987$ b/s

**b. Explain why PCM is more noise resistant than the other forms of pulse modulation. (6)**

**Answer:** **Refer page 506 of Text Book**

**c. Name any two digital modulation systems other than PCM. (2)**

**Answer:**

Differential PCM, Delta modulation

**Q.9 a. What are the advantages of optical fibers over coaxial cables? (8)**

**Answer:** **Refer page 703 of Text Book**

**b. Differentiate between echo canceller and echo suppressor. (8)**

**Answer:** **Refer pages 534 & 294 of Text Book**

**TEXT BOOK**

**I. Electronic Communication Systems, George Kennedy and Bernard Davis, Fourth Edition (1999), Tata McGraw Hill Publishing Company Ltd**