Question 1

(a) Briefly explain TWO (2) methods of FM generation and give ONE (1) example circuit for each of the method mentioned.

(6 Marks)

(b) Modulation is performed in a transmission by a circuit called a modulator. Justify FOUR (4) reasons why modulation is needed in a communication system.

(4 Marks)

(c) In an Frequency Modulation (FM) system, a carrier signal $V_c(t)=20\cos(3\times10^6\pi t)$ Volts is modulated by the message signal $V_m(t)= 10\sin(62500\pi t)$ Volts and the carrier frequency varies within 5.5% of its unmodulated value. Determine:

(i) Modulation index, m_f.

(3 Marks)

(ii) Bandwidth required, using Carson's rule.

(1 Mark)

Question2

(a) A telecommunication technician is given a task to assess the output power levels of a conventional AM transmitter with respect to different kind of modulation modes with the same intelligibility received. Given that the antenna transmits a 13.2 kW of total power at 75% modulation, determine:

(i) The total power, P_t delivers through the antenna.

(2 Marks)

(ii) The total power using Double-Side Band Suppressed Carrier (DSBSC).

(2 Marks)

(iii) The percentage of power saving of Single-Side Band Full Carrier (SSBFC) compares to Doube-Side Band Full Carrier (DSBFC).

(4 Marks)

(b) An AM modulated wave with the output wave changes of $\pm7.5V_p$ is represented by the following equation:

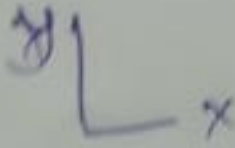$$V_{am}(t) = 20\sin(2\pi500\times10^3)t - 3.75\cos(2\pi510\times10^3)t + 3.75\cos(2\pi490\times10^3)t$$

Determine:

(i) Modulation index, m and percent of modulation.

(2 Marks)

(ii) The peak amplitude of the modulated carrier, upper and lower side of frequency voltages.

(2 Marks)

Vmax   Vrin

(iii)   The maximum and minimum amplitude of the envelope.

(3 Marks)

(iv)   Draw and label the frequency spectrum.

(2 Marks)

(v)   Sketch and label the AM modulated envelope.

(3 Marks)

Question 3

a)   Write an expression for an AM voltage wave with the following values:

   Unmodulated carrier = $20V_p$

   Modulation coefficient = 0.4

   Modulating signal frequency = 5 kHz

   Carrier frequency = 200 kHz

(3 Marks)

)   Given an FM modulated waveform $V_{FM}(t) = 4\cos\left[\left(8.6 \times 10^5\right)\pi t + 2\sin\left(27 \times 10^3\right)\pi t\right]$ is transmitted through an antenna with a load resistance $R_L = 15\ \Omega$. By referring to the Bessel Function Table in Appendix 1, answer the following questions:

(i)   Determine the carrier frequency, f_c, modulating frequency, f_m and modulation index, m_f.

(3 Marks)

(ii)   Determine the relative amplitudes of the carrier and side frequencies.

(5 Marks)

(iii)   Determine the total power in modulated carrier, P_t.

(2 Marks)

(iv)   Produce the power spectrum of the modulated output wave with their respective power amplitudes.

(3 Marks)

Vmax