Q2 Ans) Modulation index change from 0 to $1/\sqrt{2}$

A.T.Q

$$P_t = \left[\frac{2+m^2}{2} \right] P_c \quad [\text{where } m = \text{modulation index}]$$

Now we know

$m = 0$, $P_t = P_c$

New: $m = 1/\sqrt{2}$

$$\text{so} \quad P_t = \left[\frac{2 + (1/\sqrt{2})^2}{2} \right] P_c$$

$$P_t = \left[1 + \frac{1}{4} \right] P_c \Rightarrow \boxed{P_t = \frac{5}{4} P_c}$$

Now finding % change which is required $= \dfrac{5/4\, P_c - P_c}{P_c} = 25\%$ (1)

So it will increase by 25%   [from (1) we can say all this]

Q1) Given: $A_c = 1$, $A_m = 2$, $f_c = 100\,Hz$ & $f_m = 5\,Hz$

$$c(t) = A_c \cos(2\pi f_c t), \quad m(t) = A_m \cos(2\pi f_m t)$$

$$s(t) = [A_c + A_m \cos(2\pi f_m t)] \cos(2\pi f_c t)$$

Ans) a) $s(t) = A_c \cos 2\pi f_c t + A_m \cos(2\pi f_c t)(\cos 2\pi f_c t)$

$$= A_c \cos 2\pi f_c t + \frac{A_m}{2} \left[\cos(2\pi(f_m+f_c)t) + \cos(2\pi(f_c - f_m)t) \right]$$

USB

LSB

(b) Now A.T.Q

$$\hat{m}(t) = A_m \sin(2\pi f_m t)$$

$$V_{usb} = m(t) \cos(2\pi f_c t) - \hat{m}(t) \sin(2\pi f_c t)$$

$$= A_m \cos(2\pi f_m t) \cos(2\pi f_c t) - A_m \sin(2\pi f_m t) \cdot \sin(2\pi f_c t)$$

$$V_{usb} = A_m \cos(2\pi(f_m + f_c)t) = \boxed{2\cos(2\pi(105)t)}$$

similarly

$$V_{lsb} = A_m \cos(2\pi(f_c - f_m t))$$

$$\boxed{= 2\cos(2\pi(95t))}$$

Q3) Ans) Given: $c(t) = 10 \cos(2\pi \times 5 \times 10^8 t)$, $m(t) = 4\cos(2\pi \times (1250) t)$

$K_p = 2\pi$

$V_{pm}(t) = A_c \cos(2\pi f_c t + k_p 4\cos(2\pi(1250)t))$

Now instant frequency

$\omega_i(t) = \omega_c + k_p m'(t)$ $\quad$ $[m'(t) = -4 \times 2\pi \times 1250 \sin(2\pi(1250)t)]$

$\omega_i(t) = 2\pi \times 5 \times 10^8 + 2\pi(-8\pi \times 1250 \times \sin(2\pi \times 1250))$

$\omega_i(t) = 10^9\pi - 16\pi^2(1250) \sin(2\pi(1250)t)$

Now freq. Deviation

$\Delta f = \frac{k_p m'_p}{2\pi}$ $\quad$ $[$where $m'_p = [m'(t)]_{max}]$ $\quad$ & k_p given in question

$\Delta f = \frac{2\pi m'_p}{2\pi} = \boxed{4 \times 2\pi \times 1250} = \Delta f$ (3)

Now Carson's Bandwidth $= 2B(\beta + 1)$

$= \boxed{2 \times 1250 \times (8\pi + 1)}$ Hz $\quad$ $\left[B = 1250 \text{ Hz} \quad \beta = \frac{\Delta f}{B} = 8\pi \right]$ Δf from 3