Q1 ① ✓

For 1MHz offset of 20Hz

5×1000 MHz $= 20 \times 5 \times 10^3$

$= 100$ KHz

Q2

Fract = 10KHz, Integ = 90KHz

Fractional will cause ICI. should be eliminated & compensated in time domain

Q3 Demodulate $r_c(t) = [s(t)\sqrt{2}\cos(\omega_c t - \theta)]_{LPF}$

$= \left[\left(2I(t)\cos(\omega_0 t) - 2Q(t)\sin(\omega_0 t)\right) \cos[(\omega_0 t)\cos\theta + \sin(\omega_0 t)\sin\theta] + n_c(t) \right]_{LPF}$

$= \left[I(t)(1+\cos(2\omega_0 t))\cos\theta - Q(t)\left[1-\cos(2\omega_0(t))\right]\sin\theta \right]_{LPF} + n_c(t)$

$= I(t)\cos\theta - Q(t)\sin\theta + n_c(t)$

Demodulate $r_s(t) = \left[s(t)\sqrt{2}\sin(\omega_0 t - \theta) \right]_{LPF}$

$= 2\left(\left[I(t)\cos(\omega_0 t) - Q(t)\sin(\omega_0 t) \right] \sin(\omega_0 t)\cos\theta - \cos(\omega_0 t)\sin\theta \right)_{LPF}$

$= 2\left[I(t)\cos(\omega_0 t)\sin\theta - Q(t)\sin^2\omega_0(t)\cos\theta \right] + n_s(t)$

$= I(t)\sin\theta + Q(t)\cos\theta + n_s(t)$

$r_c(t) + r_s(t) = I(t)\{\cos\theta + \sin\theta\} - Q(t)\{$

$$= I(t)\cos\theta - Q(t)\sin\theta + j[I(t)\sin\theta + Q(t)\cos\theta] + n(t)e^{-j\theta}$$

$$= [I(t) + jQ(t)](\cos\theta + j\sin\theta) + \hat{n}(t)$$

$$= [I(t) + jQ(t)]e^{j\theta} + \hat{n}(t)$$

$$= s(t)e^{j\theta} + \hat{n}(t)$$