1. $f_s = 11.025 \text{ kHz}$

$$\therefore T_s = \frac{1}{f_s} = \frac{1}{11.025} \times 10^{-3}$$

$$= 0.0907 \times 10^{-3} \text{ sec}$$

$$= 90.7 \times 10^{-6} \text{ sec}$$

$$= \underline{\underline{90.7 \, \mu\text{sec}}}$$

acquisition time = $10 \, \mu\text{sec}$

$\therefore$ time available for quantization and digitization =

$$90.7 \, \mu\text{sec} - 10 \, \mu\text{sec}$$

$$= \boxed{80.7 \, \mu\text{sec}}$$

2.

a. $x(t) = \cos(20t + 12^\circ)$

$$\therefore 2\pi f_{max} = 20$$

$$\therefore f_{max} = \frac{20}{2\pi}$$

$\therefore$ Nyquist sampling rate $(f_s) = 2 f_{max} = \cancel{2} \times \frac{20}{\cancel{2}\pi}$

$$= \boxed{\frac{20}{\pi} \text{ Hz}}$$

(b) $x(t) = 2\sin\left(\frac{5000\pi t}{3}\right)$

$\therefore\ 2\pi f_{max} = \frac{5000\pi}{3}$

$\therefore\ f_{max} = \frac{5000}{3 \times 2}$

$\therefore$ Nyquist sampling rate : $f_s = 2 \times f_{max}$

$= \cancel{2} \times \frac{5000}{3 \times \cancel{2}}$

$= \boxed{\frac{5000}{3}\ Hz}$

(c) $x(t) = \sin\left(\frac{3000\pi t}{7} + \frac{\pi}{10}\right)$

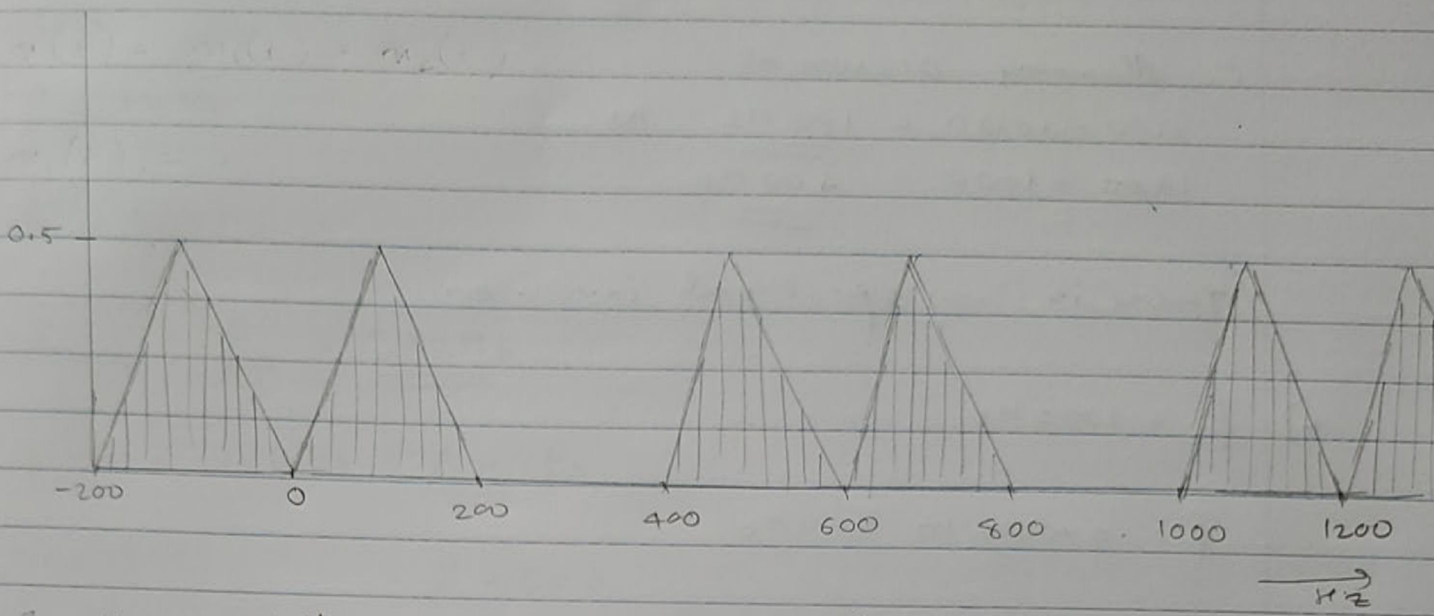
$\therefore\ 2\pi f_{max} = \frac{3000\pi}{7}$

$\therefore\ f_{max} = \frac{3000}{7 \times 2}$

$\therefore$ Nyquist sampling rate $= f_s = \cancel{f_m}\ 2 \times f_{max}$

$= \cancel{2} \times \frac{3000}{7 \times \cancel{2}} = \boxed{\frac{3000}{7}\ Hz}$

3. $f_s = 600\,Hz$



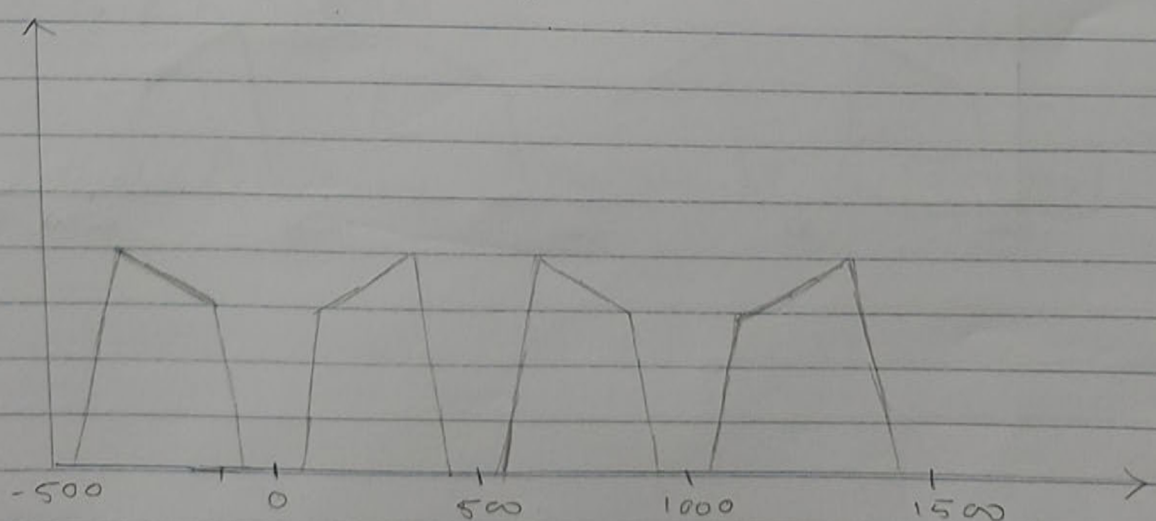
$\therefore$ the spectrum repeats at kf_s where k is an integer $= 0, 1, 2, 3 \ldots$

4. $f_s = 1\,kHz = \underline{\underline{1000\,Hz}}$

a) $f_s = 1000\,Hz$

$f = 1100$ to $1400\,Hz$

The signal replicates symmetrically in $kf_s - f$



$f_s < 2 f_{max}$

$\therefore$ Aliasing occurs at:

$1100 - 1000 = \underline{\underline{100\,Hz}}$ to

$1400 - 1000 = \underline{\underline{400\,Hz}}$

There is no spectral inversion.

b) $f_s = 1000\,Hz$

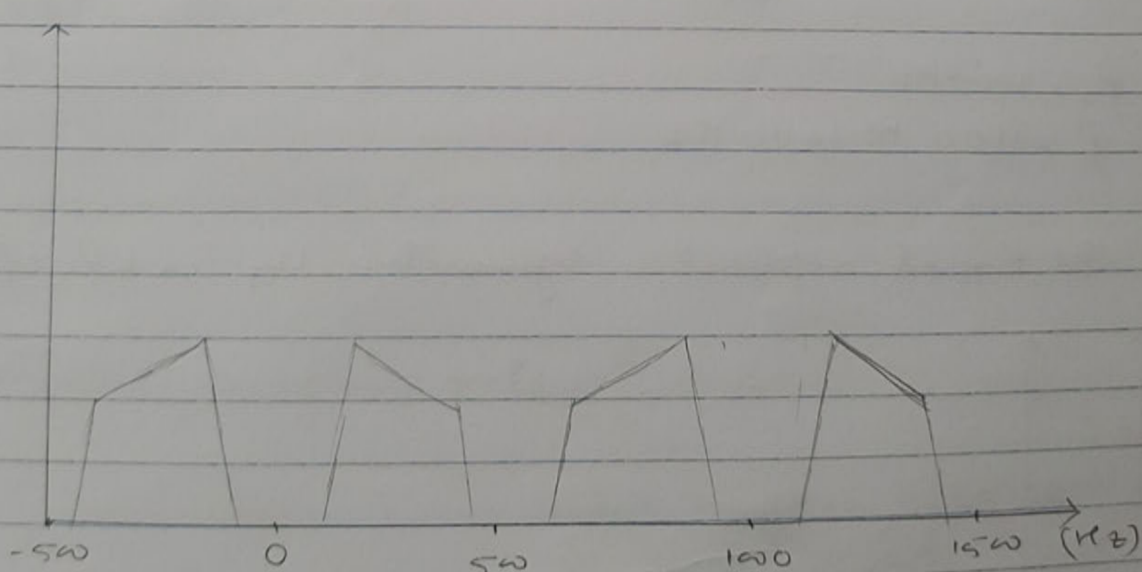
$f = 800\,Hz$ to $950\,Hz$

$\therefore$ Aliasing occurs at:

$1000 - 950 = 50\,Hz$ to

$1000 - 800 = 200\,Hz$

→ Spectral inversion occurs at the baseband.



5.

$x(t) = \sin(2\pi f t)$

$f < 1\,kHz$

$f_s = 600\,Hz$

$f_{max} = \frac{f_s}{2} = 300\,Hz$

given: $150\,Hz = f - f_s$

$= f - 600$

$\therefore f = 600 + 150$

$= \boxed{750\,Hz}$

Also, verifing from the second case:

given: $200 = f - f_s$

$\therefore 200 = f - 550$

$\therefore \boxed{f = 750\,Hz}$

$\therefore$ Actual frequency of the signal is $\boxed{750\,Hz}$