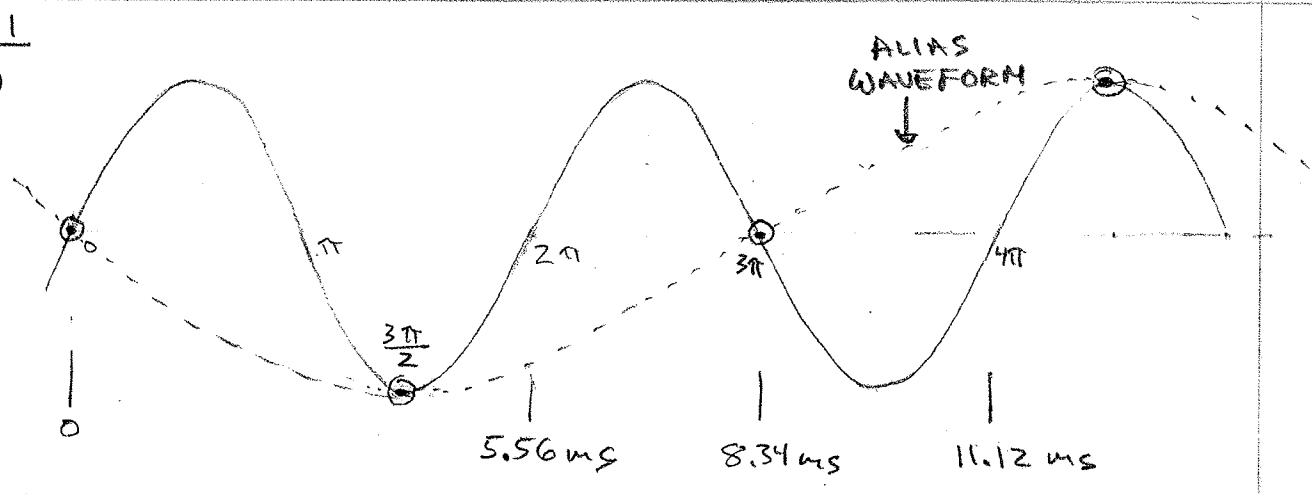
HW # 4 SOLUTION

PROB 1

a)




$\frac{1}{180} = 5.556$ ms

$\frac{1}{240} = 4.1667$ ms

$\frac{4.1667}{5.5556} = .75$

$\Rightarrow$

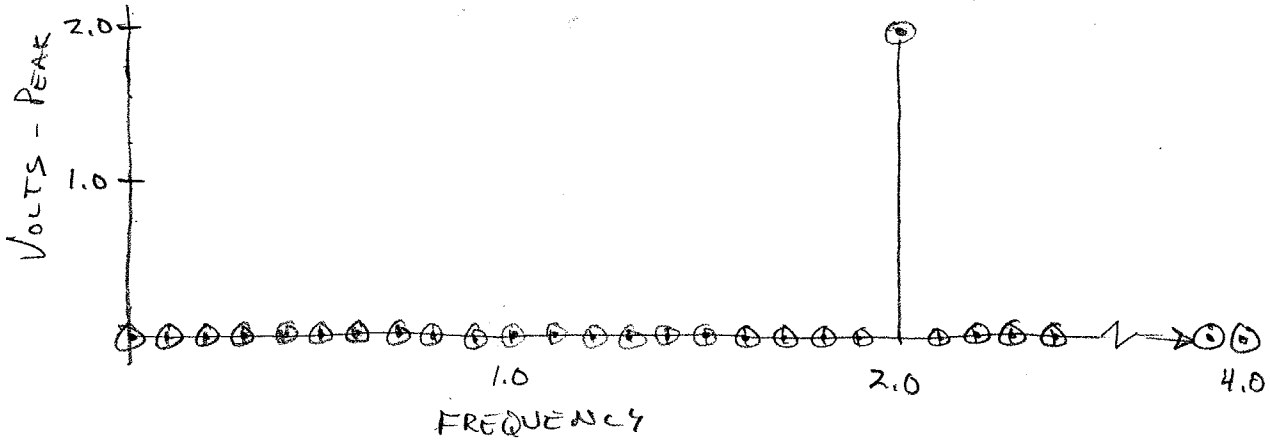
- EACH PERIOD OF 180 Hz = 2π RADIANS
- "DISTANCE" BETWEEN SAMPLES IS $\frac{4.1667}{5.5556} \times 2\pi = \frac{3\pi}{2}$ RADIANS OF THE 180 Hz WAVE
- $\frac{1}{2}$ PERIOD OF ALIAS WAVEFORM = 3π RAD
- THUS 1 PERIOD OF ALIAS WAVE IS 6π RADIANS @ 180 Hz OR 3 TIMES LONGER THAN THE 180 Hz WAVE.

b) $\therefore$ FREQ ALIAS $= \frac{1}{3(5.56\text{ ms})} = 60$ Hz

PROB 2

a) IF THE WING OSCILLATION RATE IS 2 Hz THEN THE ABSOLUTE MINIMUM SAMPLE RATE IS 4 Hz. BUT, THE PROBLEM STATES <u>ABOUT</u> 2 Hz. THUS TO BE SAFE SAMPLE AT 8 Hz OR MORE.

b) ASSUME THE OSCILLATION IS 2Hz, $F_S = 4$Hz, 10 secs DATA LENGTH.
FREQUENCY RESOLUTION WILL BE $\frac{1}{10\text{ secs}} = 0.1$ Hz



3) $100\left(1 + .004\,^{\circ}/_{C} \times (25 - 20\,^{\circ}C)\right) =$ 102 Ω @ 25°C

4) RESISTANCE AT 100°C

$100\left(1 + .004\,^{\circ}/_{C} \times (100 - 20\,^{\circ}C)\right) =$ 132 Ω @ 100°C

SELF HEATING

$\text{POWER} = I^2R = (.008)^2 \times 132 = 8.45\,mW$

$\text{TEMPERATURE RISE OF SENSOR} = \frac{8.45\,mW}{25\,mW/^{\circ}C} = 0.338\,^{\circ}C$

RESISTANCE W/SELF HEATING

$100\left(1 + .004\,^{\circ}/_{C} \times (100.34 - 20\,^{\circ}C)\right) = 132.135\,\Omega$

INDICATED TEMP = 100.338°C

5) LET THE STARTING TEMP = 20°C

$V_{OUT} = 5V \frac{R_S}{R_S + 100} = 5V \frac{100}{100+100} = 2.50\,V$

AT TEMP = 21°C $R_S = 100(1 + .004) = 100.4\,\Omega$

$V_{OUT} = 5V \frac{100.4}{100.4 + 100} = 2.50499$

$\Delta V$ FOR 1°C CHANGE IS $2.50499 - 2.50 = 4.99\,mV \sim 5\,mV$

RESOLUTION OF A VOLTMETER WOULD NEED TO BE GREATER THAN 5mV SAY 2.5mV TO FOR SURE SEE THE VOLTAGE CHANGE

6) $V_{OUT}$ AT 20°C WOULD BE 2.50 V AS BEFORE

AT TEMP = 21°C $R_S = 100\Omega - (.05)(100) = 95\,\Omega$

$V_{OUT} = 5V \frac{95}{95 + 100} = 2.4359\,V$

$\Delta V = 2.5000 - 2.4359 = 64.1\,mV$ MIN RESOLUTION

7) $411\,^{\circ}C = 22.455\,mV$ $412\,^{\circ}C = 22.510\,mV$ FROM TABLE 8.6

$\text{TEMP} = 411\,^{\circ}C + \frac{22.5 - 22.455}{22.510 - 22.455} = 411.82\,^{\circ}C$

8) @ 300°C V = 12.209 mV FOR K-TYPE THERMOCOUPLE