Mechatronics
Assignment -1

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Q.1 a) Equation for ideal straight line:

$y = mx + c$

for 0-100°c,

$m = \frac{5268 - 0}{100 - 0} = 52.68$

$C = 0$

100 - 200°c,

$m = \frac{10777 - 5268}{200 - 100} = 55.09$

$c = -241$

200 - 300°c,

$m = \frac{16325 - 10777}{300 - 200} = 55.48$

$C = -319$

300 - 500,

$m = \frac{27388 - 16325}{500 - 300} = 55.31$

$C = -264.5$

Straight line eq,

$$y = \begin{cases} 52.68x + 0 & , x \in [0, 100] \\ 55.09x - 241 & , x \in (100, 200] \\ 55.48x - 319 & , x \in (200, 300] \\ 55.31x - 269.5 & , x \in (300, 500] \end{cases}$$

for the full range eq.,

$$y = \left(\frac{27388 - 0}{500 - 0}\right) x + 0$$

$$y = 54.77x$$

b) at 100°c,

ideal = 5477 μV
actual = 5268 μV
Δ output = −209 μV

$$\% \, fsd = \frac{|-209|}{27388} \times 100 = 0.76\%$$

for 300,

$$\% \, fsd = \frac{|16431 - 16326|}{27388} \times 100 = 0.39\%$$

classmate
Date
Page

Q.3

h	Δ output
0	0.14
1.5	0.90
3.0	0.90
4.5	1.15
6.0	1.21
7.5	1.35

maximum Δ output $= 1.35$

maximum hysterisis as fsd % $= \frac{1.35}{(10.2-0)} \times 100$

$= 13.24\%$

Q.4 i) a) resolution $= \frac{fsd}{2^8} = \frac{5}{256} = 19.53\,mV$

% fsd $= \frac{19.53 \times 10^{-3}}{5} \times 100 = 0.39\%$

b) resolution $= \frac{fsd}{2^{16}} = \frac{5}{2^{16}} = 76.29\,\mu V$

% fsd $= \frac{76.29 \times 10^{-6}}{5} \times 100$

$= \cancel{\frac{15.258}{10^4}}$ $15.258 \times 10^{-4}\,\%$

ii) range is : 0-10V

rising level $= 2.95V$

falling level $= 3.05V$

$\Delta y = 0.10V$

hysterisis as % fsd $= \frac{\Delta y}{fsd} \times 100 = \frac{0.1}{10} \times 100 = 1\%$

2 a) Standard conditions (I) are 20°C, 10V

$$K = \frac{O_{max} - O_{min}}{I_{max} - \cancel{8}I_{min}} = \frac{20-4}{10-0} = 1.6\,mA/barg$$

$$a = bias = O_{min} - K \cdot I_{min} = 4\ barg$$

condition II,

$$K_{II} = K + K_m \cancel{\times} I_m$$

$$\frac{28-4}{10-0} = 1.6 + k_m \times 2$$

$$K_m = 0.4\,mA\,\cancel{/}\,barg^{-1}\,V^{-1}$$

$$a_{II} = a + k_I I_I$$

$$4 = 4 + k_I \times 2$$

$$k_I = 0$$

condition III,

$$K_{III} = K + K_m I_m$$

$$\frac{22-6}{10-0} = 1.6 + \cancel{8}\,K_m \cdot \cancel{I_m}$$

5 Km

$$K_m = 0$$

$a_{III} = a + K_I I_I$

$6 = 4 + 5K_I$

$\underline{K_I = 0.4\,V/\%}$

b) $O(I) = (K + K_m I_M) I + a + K_I I_I$

At 25°C, 12V,

$I_M = 2V$

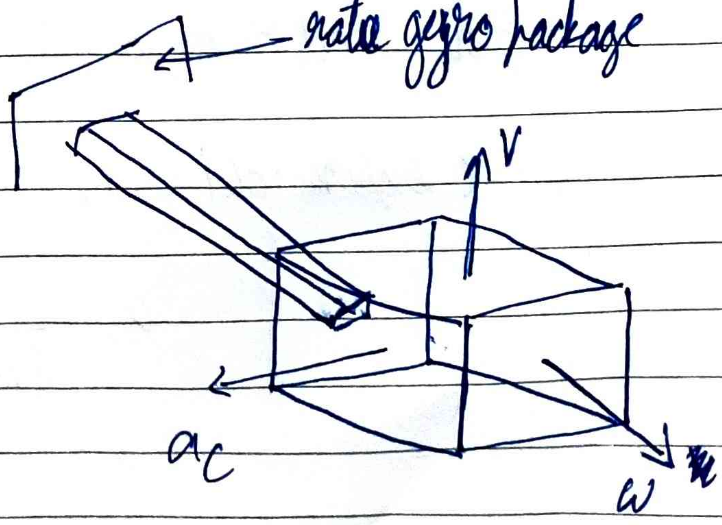
$I_I = 5\%$

$O(5\,bar) = (1.6 + 0.4 \times 2) \times 5 + 4 \times 0.4 \times 5$

$= 2.4 \times 5 + 4 + 2$

$= \underline{18\,mA}$

Q.5



Micro Electro Mechanical System (MEMS) gyroscope uses the ~~gg~~ principle of ~~gg~~ conservation of angular momentum, to detect orientation changes using coriolis acceleration

It consists of a small body, often a disk mounted using springs ~~an~~ as such that it is free to move around. A set of electrodes detects this motion and converts it to signal

Angular velocity causes the structure to experience coriolis ~~Ea~~ acceleration. It oscillates, thus at a frequency proportional to aangular vel. the structure then changes the capacitance between electrodes which can be measured.

$\omega = 2\pi f$ = angular vel

coriolis accel = $a_c = 2\omega v$ (see diagram)

force experienced = $F_c = ma_c$
$= 2m\omega v$

$\omega = \frac{1}{2mv}$ (m = mass)