Q.P.Code: 37823

Subject: Signal Conditioning Circuit Design
SE (Instrumentation) (CBCGS)

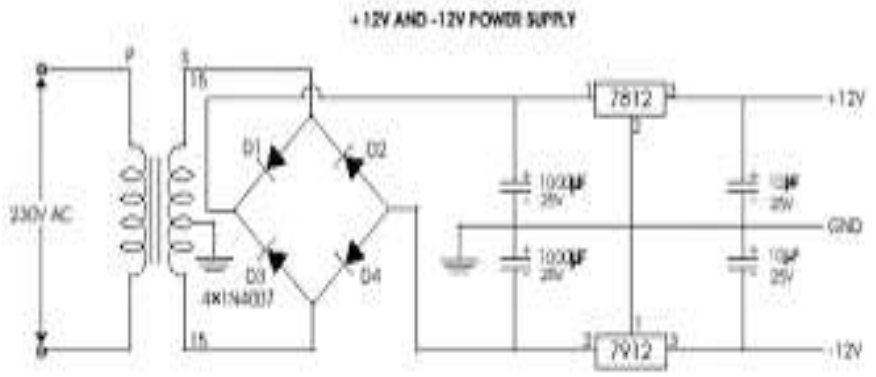
N. B. 1) Question No. **1** is **compulsory (Any Four)**.
2) Answer any **3** questions from the remaining **5** questions.
3) Assume suitable data wherever necessary.

Q1 (a) Write a short note on zero crossing detector. **20**
(b) Describe the term loading effect with suitable example.
(c) The resistors in a bridge are given by R1=R2=R3=120 Ω and R4 = 121 Ω. If the supply voltage is 10V. Find the offset voltage.

$$\Delta V = V \frac{R_3 R_2 - R_1 R_4}{(R_1 + R_3)(R_2 + R_4)}$$

$$\Delta V = -20.7mV$$

(d) Draw and explain Sample and Hold circuit.
(e) Design a ±12V power supply using IC 78xx.

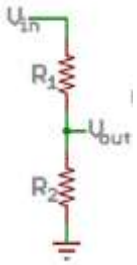


Q2 (a) Define multivibrator? Explain astable multivibrator using IC 555 and also design astable multivibrator for 50% duty cycle. **20**

(b) Draw and explain circuit for ideal integrator with waveforms. Discuss the

problems associated with ideal integrator and draw the circuit diagram for practical integrator.

Q3 (a) A thermistor is to monitor room temperature. It has a resistance of 3.5 KΩ at 20°C with a slope of -10%/°C. The dissipation constant is P_D=5mW/°C. It is proposed to use the thermistor in the divider as shown below to provide a voltage of 5.0V at 20°C. Evaluate the effect of self-heating. (R_2= Thermistor; R_1=3.5KΩ) **20**



At 20°C , the thermistor resistor will be 3.5KΩ , and the divider voltage will be

$$V_D = \frac{3.5\text{K}\Omega}{3.5\text{K}\Omega + 3.5\text{K}\Omega} 10 = 5V$$

The power dissipation in the thermistor

$$P = \frac{V^2}{R_{TH}}$$

=7.1mW

Temperature rise of the thermistor

$$\Delta T = \frac{P}{P_D} = \frac{7.1mW}{5mW/°C} = 1.42°C$$

The Thermistor Resistance is given by

$$R_{TH} = 3.5\text{K}\Omega - 1.42℃(0.1/℃)(3.5\text{K}\Omega)$$

=3.0 KΩ

$$V_D = 4.6V$$

(b) Draw and explain the principle and construction of metal strain gauges. What is the signal conditioning associated with it.

Q4 (a) Explain successive approximation analog to digital converter. Find ADC output for a 4-bit converter to a 2.187V input, if the reference is 5V. **20**

Set b_1 =1 ⟹ $V_F = 5(2^{-1}) = 2.5V$

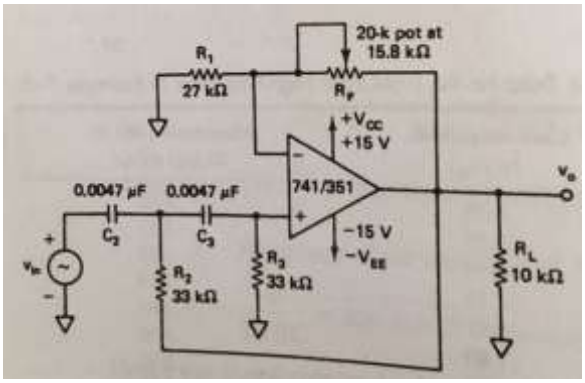
b_2 =1 ⟹ $V_F = 5(2^{-2}) = 1.25V$

b_3 =1 ⟹ $V_F = 5(2^{-3}) = .625V$

b_4 =1 ⟹ $V_F = 5(2^{-4}) = .3125V$

$b_2b_3b_4$ =1.25+.625+.3125=2.187

(b) Design a second order high pass filter for cutoff frequency equal to 1.5 KHz.



$$f_L = \frac{1}{2\pi\sqrt{R_2 R_3 C_2 C_3}}$$

Assume $C_2 = C_3 = C = .0047\mu F$, and $R_2 = R_3 = R$;

$$f_l = \frac{1}{2\pi RC}$$

R=22.5KΩ

$$Gain = 1 + \frac{R_F}{R_1}$$

Assume R_1=27KΩ ; R_F=15.8 KΩ

Q5 (a) A potentiometric displacement sensor is to be used to measure work-piece motion from 0 to 10 cm. The resistance changes linearly over this range from 0 to 1KΩ. **20**

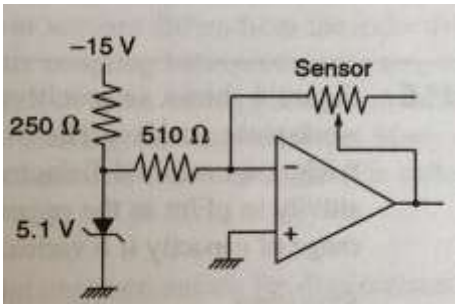
Develop signal conditioning to provide a linear, 0- to 10-V output.

$$V_{out} = -\frac{R_2}{R_1} V_{in}$$

Negative sign can be removed by using a constant negative voltage (Zener diode)

$$10 = -\frac{1000}{R_1}(-5.1)$$

=510Ω



(b) Explain the absolute value circuit with labelled circuit diagram and its

waveform.

Q6	(a)	Draw and explain the principle and construction of RTD. What is the signal conditioning associated with it.	**10**
	(b)	Phase Locked loop	**5**
	(c)	SMPS	**5**