Reg. No.									

MANIPAL INSTITUTE OF TECHNOLOGY

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A Constituent Institution of Manipal University

I SEMESTER M.TECH (POWER ELECTRONICS & DRIVES / ENERGY SYSTEMS & MANAGEMENT)

END SEMESTER EXAMINATIONS, NOV/DEC 2016

SUBJECT: INSTRUMENTATION IN ELECTRICAL SYSTEMS [ELE 5105]

REVISED CREDIT SYSTEM

Time: 3 Hours **Date: 07 December 2016** **MAX. MARKS: 50**

Instructions to Candidates:

- Answer **ALL** the questions.
- Missing data may be suitably assumed.

1A. A thermocouple shown in **Fig1A**. has a transfer function linking its voltage output V and temperature input of T as:

$$G(s) = \frac{30 * 10^{-6}}{10s + 1} volts/^{\circ}\text{C}$$

Determine the response of the system when it is suddenly immersed in a water bath at 100^0C. From the response, comment on its dynamic characteristics. ***(03)***

1B. Define Piezo-resistive effect. From the initial state, derive an expression to prove that gauge factor of a strain gauge is dependent on the resistance change due to piezo resistive effect. ***(03)***

1C. With suitable diagrams, derive the expressions for reflection and transmission coefficients in plane wave shielding theory. Hence, prove that, the shielding effectiveness of an infinite sheet of good conductor is dependent on the reflection loss as well as absorption loss

Calculate the shielding effectiveness for a sheet of silver whose thickness is $50.8\mu m$ and has a conductivity $\sigma = 6.3 \times 10^7\ \mho/m$ at 10^8 Hz. ***(04)***

2A. A thermistor has a resistance of 3980Ω at the ice point (0°C) and 794Ω at 50°C. The temperature – resistance relationship is given as $R_t = aR_0e^{b/T}$

- Calculate the constants a and b.
- Calculate the range of resistance to be measured in case the temperature varies from 40°C to 100°C

(03)

2B. **Fig2B**. shows a horizontal nozzle discharging into the atmosphere. The inlet has a bore area of $600mm^2$ and the exit has a bore area of $200mm^2$. Calculate the flow rate when the inlet pressure is 400 Pa. Assume there to be no energy loss. ***(03)***

2C. With a neat diagram, explain the working of capacitive transducers working on the principle of differential arrangement. Further, prove that the differential output voltage varies proportionately to the displacement of the movable plate. ***(04)***

3A. For the active amplifier circuit shown in **Fig. 3A**, considering

$$\frac{R_2}{R_1} = \frac{R_2'}{R_1'}$$

Prove that the output voltage can be expressed as:

$$V_0 = (V_2 - V_1)\left[1 + \frac{R_2}{R_1} + \frac{2R_2}{R_g}\right] + V_{ref}$$ ***(03)***

3B. With a neat diagram, explain the principle of magnetic isolation using active devices. Highlight the role played by phase sensitive modulators as well as phase sensitive demodulators in this signal isolation technique. ***(03)***

3C. Derive the mathematical model of a band pass active filter depicted in **Fig. 3C**. Also, calculate its lower and upper cut off frequencies along with the voltage amplification factor if the values of the passive components are given below:

$$R_1 = R_2 = 10K\Omega;\ R_{f1} = R_{f2} = 100K\Omega;\ R_L = R_H = 10K\Omega;\ C_L = 1\mu F;\ C_H = 1pF\ .$$ ***(04)***

4A. Shock sensors are widely used in detecting abnormal vibrations in industrial motors. They behave like piezoelectric sensors. In the application here, the motor runs at 500Hz for which, the maximum shock sensed is 50G. The electric signals from the shock sensor is fed to a charge amplifier configured in its charge mode. The charge source is defined to be $0.35pC/G$, while the shunt resistor and capacitor were defined to be $10G\Omega$ and $390pF$ respectively. The cable length used here was 1 meter with its capacitance being $100pF$. The analog platform is designed in such a manner that for zero input, the voltage output too should be zero. The resonant frequency of the shock sensor is $28KHz$. Considering the feedback resistance of the charge mode amplifier to be $10M\Omega$, design the analog signal conditioning platform (amplifier along with the active filters) such that voltage output for a fixed pass band of $160\text{Hz} - 2\text{KHz}$ is obtained. Also, determine the voltage output for the maximum shock that was sensed. ***(03)***

4B. With a neat diagram and corresponding graph, explain the working of a dual slope analog to digital converter. ***(03)***

4C. With a neat diagram, explain the working of an R-2R resistor ladder digital-analog converter. For a reference voltage of 5V, create a table of analog voltage output of a 4 bit R-2R digital-analog converter. Let $R = 100K\Omega, R_f = 400K\Omega$. ***(04)***

5A. With a neat diagram, explain the various elements of a Distributed control system (DCS). Also list out the advantages of using DCS for process control. ***(03)***

5B. With a neat diagram, explain the working of a linear voltage regulator employing the standard NPN Darlington with PNP driver. ***(03)***

5C. With a neat diagram and accompanying waveforms of diode voltage, diode current, input current as well as output current, explain the working of an ideal Buck converter. ***(04)***

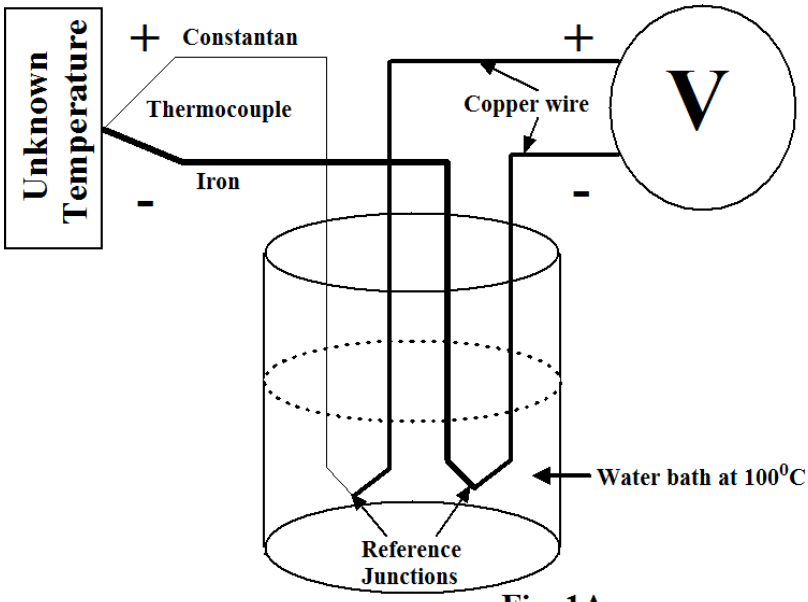

Fig. 1A

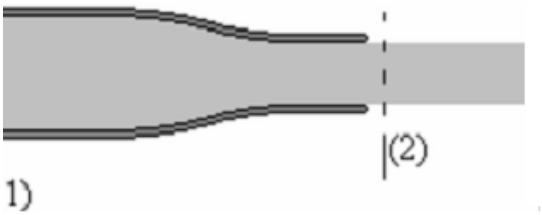

Fig. 2B

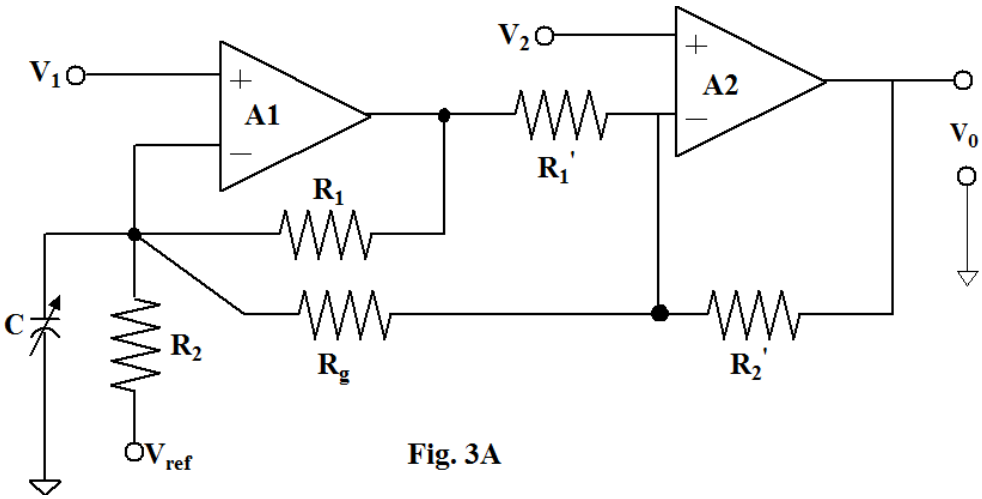

Fig. 3A

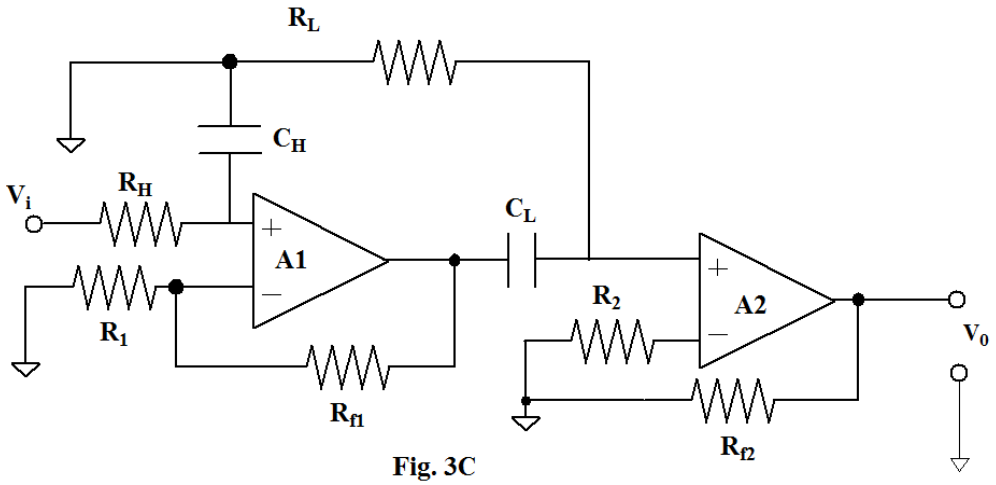

Fig. 3C