Reg. No.									

MANIPAL INSTITUTE OF TECHNOLOGY

MANIPAL

(A constituent unit of MAHE, Manipal)

VI SEMESTER B.TECH (ELECTRICAL & ELECTRONICS ENGINEERING)

MAKE-UP EXAMINATIONS, JUNE 2018

SUBJECT: MEASUREMENTS & INSTRUMENTATION [ELE 3202]

REVISED CREDIT SYSTEM

Time: 3 Hours **Date: 18 June 2018** **Max. Marks: 50**

Instructions to Candidates:

- Answer **ALL** the questions.
- Missing data may be suitably assumed.
- All passive components must be selected to their standard values from the table provided

1A. What is piezo resistive effect? With appropriate explanations, derive an expression for gauge factor of strain gauges ***(03)***

1B. A resistance of approximate value of 50Ω is to be measured by Voltmeter- Ammeter method using a 1A ammeter having a resistance of 2Ω and a voltmeter of 50V with a resistance of 5000Ω .

a. Suggest which of the two methods is to be used.
b. Determine the measured and true value of resistances
c. Determine the relative error by two circuit combinations. If the reading of the meters are 0.67A and 36.1V, with an accuracy of ±0.5%FS, calculate the true value of resistance. (error corresponds to standard deviation) ***(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 $\sigma = 6.3 \times 10^7$ ℧$/m$ at 10^8 Hz. ***(04)***

2A. In an electrodynamometer instrument the total resistance of voltage coil circuit is 8.2kΩ and mutual inductance changes from -173μH at zero deflection to +175μH at full scale deflection of 95°C. If 100V potential difference is applied across voltage circuit, current of 3A at a power factor of 0.75 is passed through current coil. What will be the deflection if the spring constant is $4.63 \times 10^{-6}\ N - m/rad$. ***(03)***

2B. An instrument system consists of pressure transducer with a range of 0 to 5 bar and a corresponding output of 0 to 10 mV. The output is connected to an electronic processor which converts the output into a current in the range 4 to 20 mA, and an analogue meter which indicates the measured pressure.

a. Deduce and write down the equation linking the output and input of the pressure transducer.
b. Deduce and write down the equation linking the input and output of the processor.
c. The output of the signal processor is 15 mA. Deduce the indicated pressure. ***(03)***

2C An RTD with its signal conditioning circuit to give corresponding output voltage (Vout) is shown in the **Fig. 2C**. The design is such that Vout is zero for a temperature of 25^0C and RTD gives a resistance (Rt) of 1kΩ at rated temperature of 25^0C. Find the temperature the output (Vout) is changed to 3V. Assume Vdc=5V, Temperature coefficient of RTD is 0.00393Ω/^{0}C, $R_a = R_b = R_c = R2 = R = 1k\Omega$ and $R3 = 10k\Omega$. ***(04)***

3A. A temperature transducer is used to measure a temperature range of 0K to 2000 K for a thermal heating chamber application. The transducer characteristics are as shown in **Fig 3A**. Design an appropriate signal conditioning circuit considering that the output of signal conditioning circuit is to be observed for the full range (-10V to +10V) of ADC respectively for further processing. Consider Standard/ Practical power supply is available. Sketch the circuit diagram of the entire signal conditioning unit. ***(03)***

3B. Design an active signal conditioning circuit using OPAMP to be interfaced with AD590 IC temperature transducer so as to produce 0V at 0°C and 10V at 100°C. The rate of conversion of AD590 is 1μA/^{0}K. ***(03)***

3C. 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 variable speeds and 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 $28Hz$. Design the analog signal conditioning platform (amplifier along with the active filters) such that voltage output for a fixed pass band of 5-200Hz is obtained. ***(04)***

4A. Derive the transfer function for second order Sallen-Key filter design working as low pass filter with the help of neat schematic. Also determine, the equations for cut-off frequency and quality factor. ***(03)***

4B. 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)***

4C. For the active amplifier circuit shown in **Fig. 4C**, through appropriate assumptions,

Prove that the output voltage can be expressed as:

$$V_0 = (V_2 - V_1)\left[1 + \frac{R_2}{R_1} + \frac{2R_2}{R_g}\right] + V_{ref}$$ ***(04)***

5A. With the help of neat schematic describe the working of R-2R Ladder Network DAC. Prove that for digital input of 0100 equivalent analog voltage is (–Vs/4) with appropriate circuit connections. Assume Vs as reference/source voltage. ***(03)***

5B. 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)***

5C. With the help of neat block diagram explain working of a Digital Energy Meter focusing on Signal Measurement, it's conditioning as well as it's display. ***(04)***

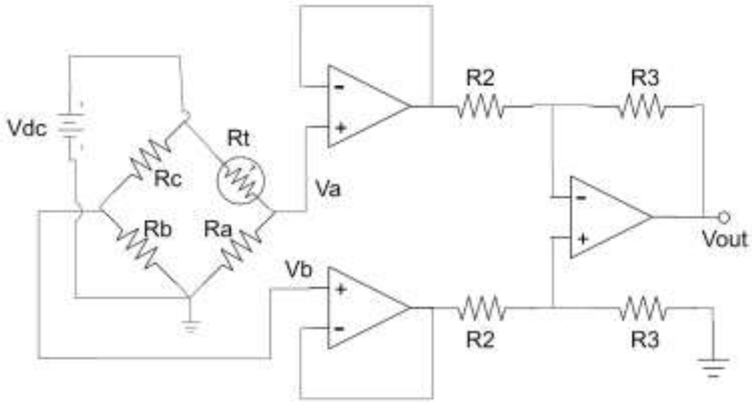

Fig. 2C

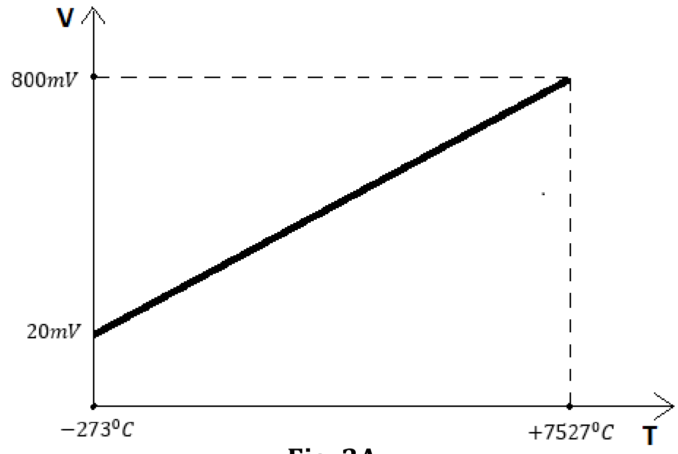

Fig. 3A

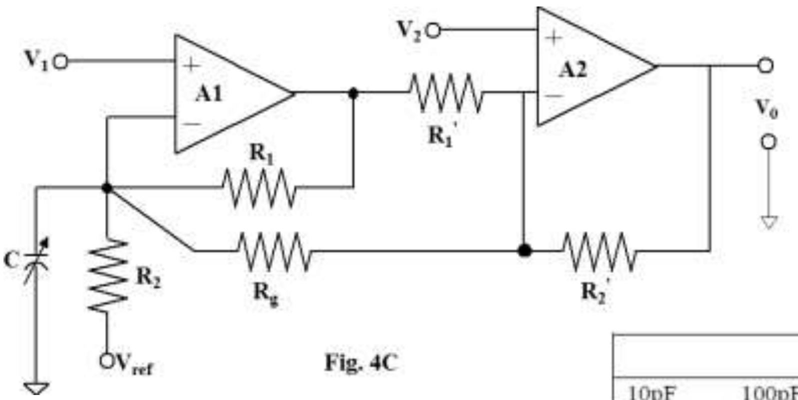

Fig. 4C

Standard Capacitor Values (±10%)						
10pF	100pF	1000pF	.010μF	.10μF	1.0μF	10μF
12pF	120pF	1200pF	.012μF	.12μF	1.2μF	
15pF	150pF	1500pF	.015μF	.15μF	1.5μF	
18pF	180pF	1800pF	.018μF	.18μF	1.8μF	
22pF	220pF	2200pF	.022μF	.22μF	2.2μF	22μF
27pF	270pF	2700pF	.027μF	.27μF	2.7μF	
33pF	330pF	3300pF	.033μF	.33μF	3.3μF	33μF
39pF	390pF	3900pF	.039μF	.39μF	3.9μF	
47pF	470pF	4700pF	.047μF	.47μF	4.7μF	47uF
56pF	560pF	5600pF	.056μF	.56μF	5.6μF	
68pF	680pF	6800pF	.068μF	.68μF	6.8μF	
82pF	820pF	8200pF	.082μF	.82μF	8.2μF	

Standard Resistor Values (±5%)						
1.0	10	100	1.0K	10K	100K	1.0M
1.1	11	110	1.1K	11K	110K	1.1M
1.2	12	120	1.2K	12K	120K	1.2M
1.3	13	130	1.3K	13K	130K	1.3M
1.5	15	150	1.5K	15K	150K	1.5M
1.6	16	160	1.6K	16K	160K	1.6M
1.8	18	180	1.8K	18K	180K	1.8M
2.0	20	200	2.0K	20K	200K	2.0M
2.2	22	220	2.2K	22K	220K	2.2M
2.4	24	240	2.4K	24K	240K	2.4M
2.7	27	270	2.7K	27K	270K	2.7M
3.0	30	300	3.0K	30K	300K	3.0M
3.3	33	330	3.3K	33K	330K	3.3M
3.6	36	360	3.6K	36K	360K	3.6M
3.9	39	390	3.9K	39K	390K	3.9M
4.3	43	430	4.3K	43K	430K	4.3M
4.7	47	470	4.7K	47K	470K	4.7M
5.1	51	510	5.1K	51K	510K	5.1M
5.6	56	560	5.6K	56K	560K	5.6M
6.2	62	620	6.2K	62K	620K	6.2M
6.8	68	680	6.8K	68K	680K	6.8M
7.5	75	750	7.5K	75K	750K	7.5M
8.2	82	820	8.2K	82K	820K	8.2M
9.1	91	910	9.1K	91K	910K	9.1M