Reg. No.									

MANIPAL INSTITUTE OF TECHNOLOGY

MANIPAL

A Constituent Institution of Manipal University

VI SEMESTER B.TECH (ELECTRICAL & ELECTRONICS ENGINEERING)
END SEMESTER EXAMINATIONS, APRIL - MAY 2017

SUBJECT: MEASUREMENTS & INSTRUMENTATION [ELE 3202]

REVISED CREDIT SYSTEM

Time: 3 Hours **Date: 25, April 2017** **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. With a neat diagram, explain and develop the mathematical model of a potentiometer having a load of resistance R_m. Let the total resistance of the potentiometer be R_p. ***(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 to be used.

b) Measured and True value of resistance

c) Determine 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.

Determine the shielding effectiveness in dB for a 20 mil thick sheet of copper ($\sigma = 5.8 \times 10^7 S/m$) at 1MHz given:

a) An electric source at a distance 1 m from the shield

b) A magnetic source at a distance 1 m from the shield ***(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 4.63×10^{-6} N − m/rad. ***(03)***

2B. The ratio arms of a Kelvin's Double Bridge (KDB) are 1000 Ω each, the galvanometer resistance $R_g = 500$ Ω, its sensitivity k=200 mm/μA, R=0.1002 Ω and S=0.1 Ω. A DC of 10 A is passed through R & S from a 2.2 V battery in series with a rheostat as shown in **Fig. 2B**. The link resistance is negligible.

a) Find the galvanometer deflection

b) Find the resistance unbalance to produce the deflection of 1 mm

c) Obtain the total internal resistance of the battery circuit. ***(03)***

2C. Define Piezo-electric effect. With a neat diagram, derive and prove that the output voltage of a piezoelectric element is dependent on the product of its voltage sensitivity, its thickness and the applied pressure. ***(04)***

3A. Mention any four main functions of signal conditioning circuit. Design a Signal Conditioning circuit using OPAMP for interfacing AD590 IC temperature transducer to produce 0V at 0°C and 10V at 100°C. The rate of conversion of AD590 is 1µA/^{0}K. ***(03)***

3B. Inserting a resistance $\boldsymbol{R_3}$ in parallel with capacitance $\boldsymbol{C}$ in the high pass filter shown in **Fig. 3B** turns it into a circuit known as zero-pole circuit that finds applications in control.

a) Sketch the modified circuit and derive its mathematical model so as to justify its name.
b) Specify standard component values for a zero frequency of 100 Hz, a pole frequency of 1 KHz and a high frequency gain of 0dB.
c) Sketch its magnitude plot highlighting the pole and zero frequencies. ***(03)***

3C. A dual OPAMP instrumentation amplifier shown in **Fig. 3C** offers an advantage in that a high CMRR can be obtained via appropriate adjustment of the pot. Derive its mathematical model and prove that:

$$V_0 = \left(1 + \frac{R_2}{R_1}\right)(V_2 - V_1)$$

(04)

4A. The unbalanced voltage of a resistance bridge is to be amplified 200 times using a differential amplifier. The configuration is shown in **Fig.4A** with $R = 1K\Omega$ and $x = 2 \times 10^{-3}$. Two amplifiers are available: one with differential gain $A_d = 200$ and CMRR= 80 dB and the other with differential gain $A_d = 200$ and CMRR= 60dB. Find the values of V_0 for both the cases and compute errors. Further, draw relevant conclusions so as to select the best amplifier. ***(03)***

4B. 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)***

4C. For a 4 bit binary weighted D/A converter having $R = 10K\Omega$; $R_f = 5K\Omega$ and $V_{ref} = -10V$, for an input binary word of 1101, determine the following:

i) Resolution
ii) Current through the MSB switch
iii) Output current
iv) Output voltage ***(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 an appropriate schematic of a 10 bit successive approximation A/D converter employing SAR, obtain the equivalent binary output for an analog voltage input of 0.6 V. Consider the reference voltage to be 1 V. Highlight all the steps involved in this A/D conversion process. ***(03)***

5C. With the help of neat block diagram explain in detail, the working of various stages in an ECG measuring system resulting in an accurate representation of the health of a patient's heart ***(04)***

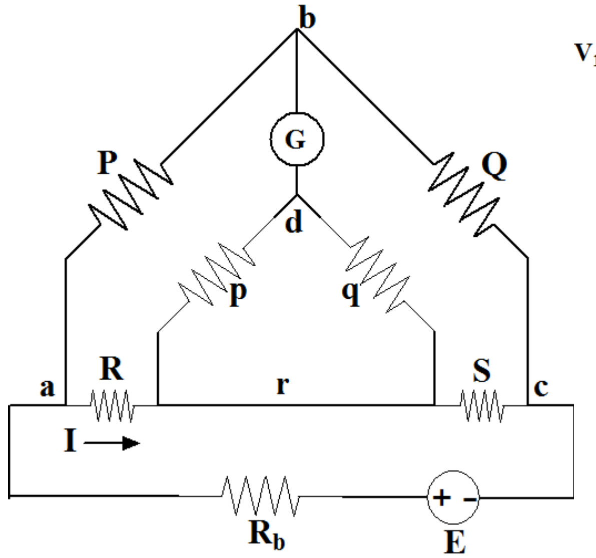

Fig. 2B

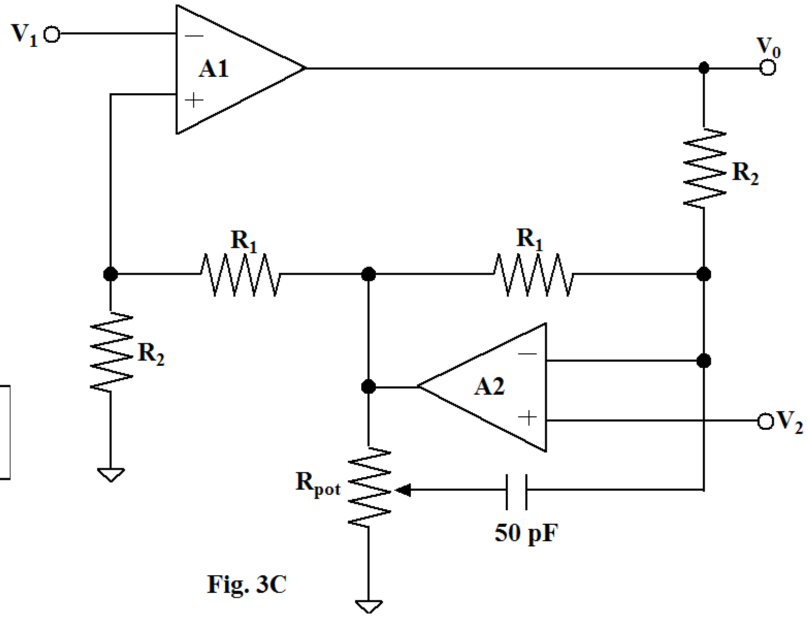

Fig. 3C

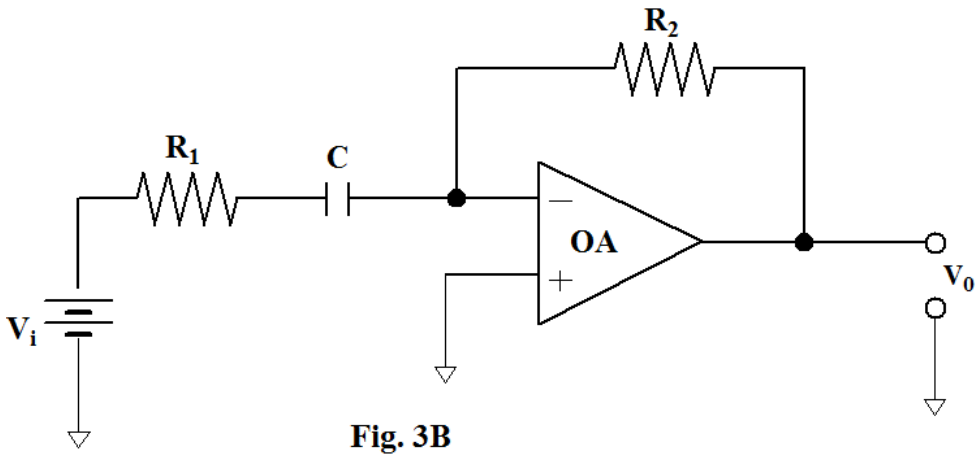

Fig. 3B

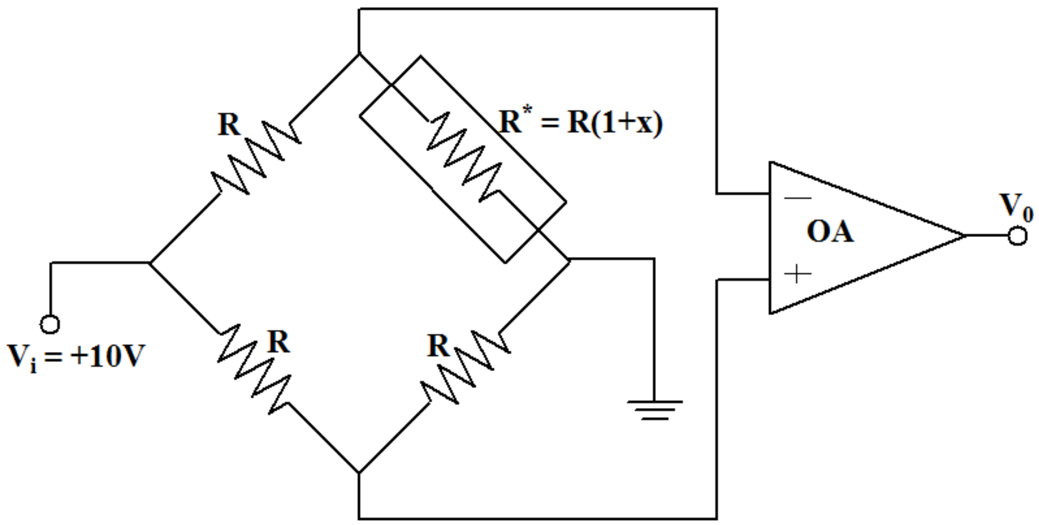

Fig. 4A

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

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	