Reg. No.									

MANIPAL INSTITUTE OF TECHNOLOGY
MANIPAL
(A constituent Institution of MAHE, Manipal)

VI SEMESTER B.TECH (ELECTRICAL & ELECTRONICS ENGINEERING)
END SEMESTER EXAMINATIONS, APRIL 2018
SUBJECT: MEASUREMENTS & INSTRUMENTATION [ELE 3202]
REVISED CREDIT SYSTEM

Time: 3 Hours **Date: 20 April 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. An energy meter has a meter registration constant of 100rev/kWh, if the meter is connected to a load drawing 20A at 230V and 0.8 power factor for 5 hours. Find the number of revolutions the meter should make for the above mentioned load. In practice, if it is found to make 1800 revolutions, find the percentage error and explain it from a consumer's point of view? ***(03)***

1B. Two different voltmeters are used to measure the voltage across R2 in the circuit in **Fig. 1B**. The meters are as follows:

a) 5 V range, Sensitivity = 20 kΩ/V.

b) 10 V range, Sensitivity = 20 kΩ/V.

Let Vs = 40V, R1 = 20 kΩ, R2 = 1 kΩ and R3 = 10 kΩ. With appropriate calculations, identify which voltmeter introduces least error due to loading. ***(03)***

1C. For a uniform plane wave propagating along the positive z-axis as shown in **Fig 1C**, assuming both the mediums to be perfect dielectrics, for a normal incidence, prove with appropriate explanations that:

a) $E_{ro}/E_{io} = \Gamma = [\sqrt{\varepsilon_1} - \sqrt{\varepsilon_2}] / [\sqrt{\varepsilon_1} + \sqrt{\varepsilon_2}]$

b) $H_{to}/H_{io} = \tau = [2\sqrt{\varepsilon_2}] / [\sqrt{\varepsilon_1} + \sqrt{\varepsilon_2}]$ ***(04)***

2A. An AC Bridge as shown in the **Fig 2A**, is used to measure an unknown inductance L_x, which has inherent resistance R_x. The bridge parameters are $R_1 = 20k\Omega$; $R_2 = 50k\Omega$; $C_2 = 0.0037\mu F$. The operating frequency $\omega = 10^5 rad/sec$. C_1 is adjustable from 10pF to 150pF and R_4 is adjustable from 0 to 10kΩ. Derive expressions for R_x and L_x to show that resistive and reactive balance are independent of each other. Also determine the largest values of R_x and L_x that can be measured with given parameters. ***(03)***

2B. 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)***

2C. A coaxial capacitor has inner and outer cylinder radii of $a = 3mm, b = 12mm$ respectively, and a length of $1m$. The region between the conducting cylinders contains three different dielectrics: $\epsilon_{R1} = 5, (3 < r < 6mm)$; $\epsilon_{R2} = 3, (6 < r < 9mm)$ and $\epsilon_{R3} = 1, (9 < r < 12mm)$.

a) Calculate the capacitance 'C'

b) Plot the variation of $'E_r'$ v/s $'r'$ if $E_{r_{max}} = 100\ V/m$. ***(04)***

3A. 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)***

3B. Design and sketch a suitable signal conditioning circuit for a transducer whose characteristics is given in **Fig. 3B** such that the output needs to be in range of 0 – 10 V for change in displacement (Δd). Also find the output voltage for a change in displacement Δd = 1.5mm. ***(03)***

3C. Design a charge mode amplifier circuit with signal conditioning for a pressure based piezo-electric transducer such that the output voltage from the setup is in the range of 0 - 5V for an input pressure range of 0 – 10 N/m^2. The output voltage is to be realized for a frequency band of 59Hz to 318Hz. The pressure-charge sensitivity of piezo material is 13.5 pC/Nm^2. Piezo shunt resistance and capacitance is 10GΩ and 4nF respectively. The connecting cable capacitance is 1nF. Assume the charge amplifier feedback resistance to be 10kΩ. ***(04)***

4A. It is proposed to employ an active filter as depicted in **Fig. 4A** in an audio amplifier. From the fundamentals, derive the mathematical model of the proposed filter and identify its type. Further, determine the cutoff frequency/frequencies and the quality factor. ***(03)***

4B. With appropriate explanations and accompanying truth table, explain the working of a 3 – bit parallel converter employing a priority encoder as shown in **Fig. 4B**. Identify the binary output for an input voltage of 5V. ***(03)***

4C. An RTD with its signal conditioning circuit to give corresponding output voltage (Vout) is shown in the **Fig. 4C**. 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 when the output (Vout) is changed to 3V. Assume Vdc=5V, Temperature coefficient of RTD is 0.00393Ω/^{0}C, $R_a = R_b = R_c = R2 = 1k\Omega$ and $R3 = 10k\Omega$. ***(04)***

5A. 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) Input current through the MSB switch
iii) Output current ***(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 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)***

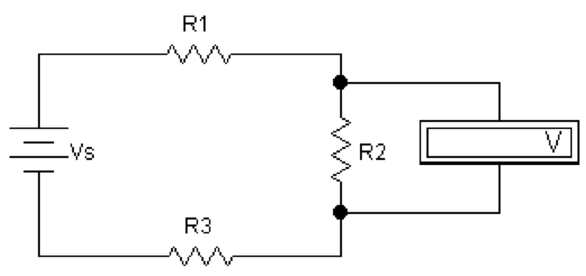

Fig. 1B

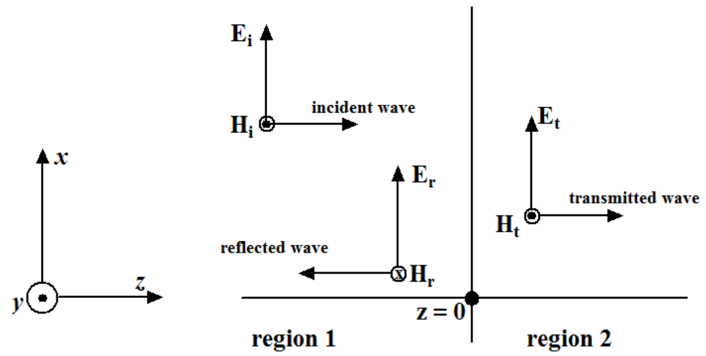

Fig. 1C

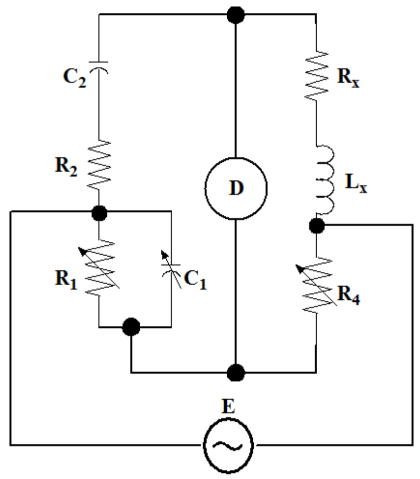

Fig. 2A

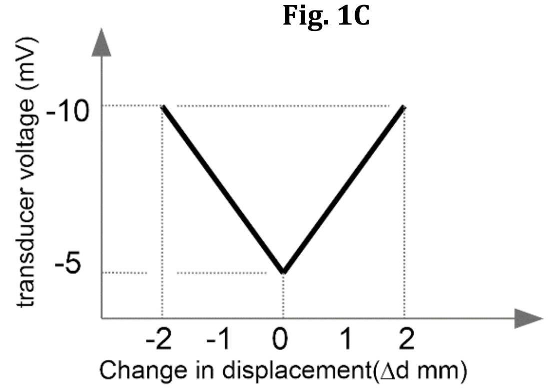

Fig. 3B

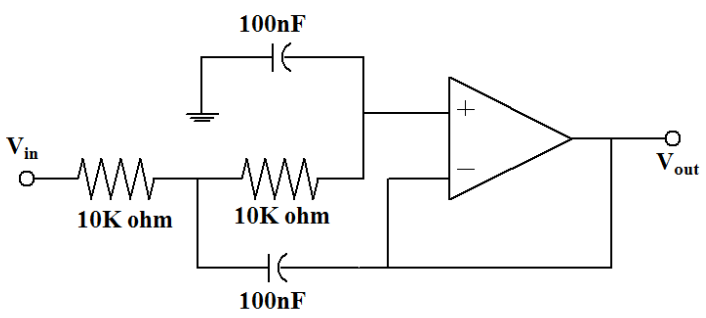

Fig. 4A

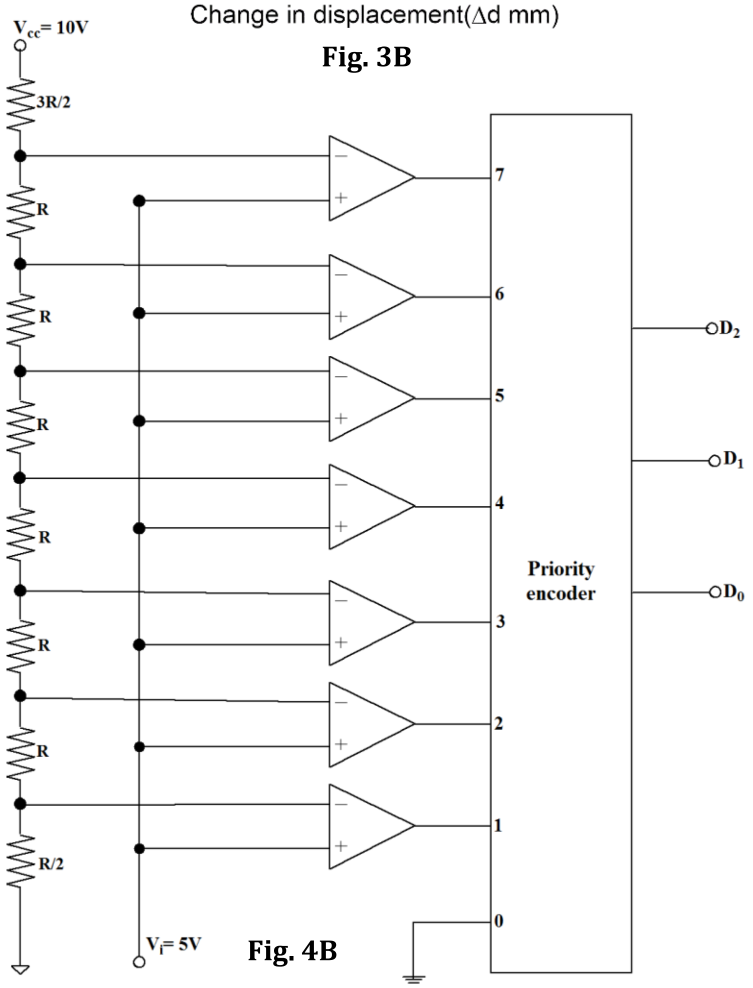

Fig. 4B

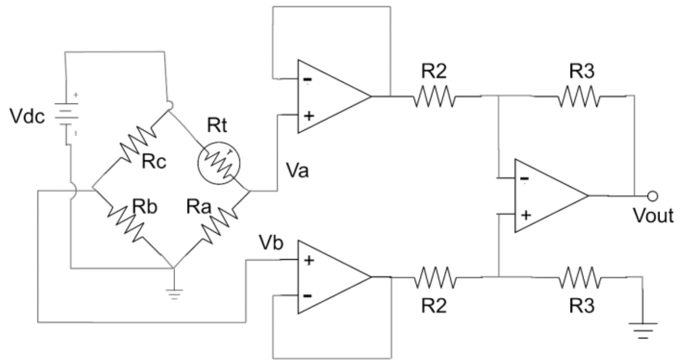

Fig. 4C

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	