Reg. No.									

MANIPAL INSTITUTE OF TECHNOLOGY
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VI SEMESTER B.TECH (ELECTRICAL & ELECTRONICS ENGINEERING)
MAKE-UP EXAMINATIONS, JUNE 2019
SUBJECT: MEASUREMENTS & INSTRUMENTATION [ELE 3202]
REVISED CREDIT SYSTEM

Time: 3 Hours **Date: 12, June 2019** **Max. Marks: 50**

Instructions to Candidates:
- Answer **ALL** the questions.
- Missing data may be suitably assumed.
- Graph Sheet may be used.

1A. 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. Calculate the measured and true value of resistance

b. 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)***

1B. Applying the related fundamentals of electromagnetic wave propagation, 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: (1 mil=0.0254 mm)

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

b. A magnetic source at a distance 1 m from the shield ***(03)***

1C. In an electrodynamometer instrument the total resistance of the voltage coil circuit is 8.2kΩ while the mutual inductance varies from -173μH at zero deflection to +175μH at full scale deflection of 95°. If 100V potential difference is applied across the voltage circuit, current of 3A at a power factor of 0.75 is passed through the current coil. What will be the deflection if the spring constant is $4.63 \times 10^{-6}\text{N} - \text{m/rad}$. ***(04)***

2A. An AC Bridge as shown in the **Fig Q2A**, 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. 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)***

2C. A coaxial capacitor has dimensions $a = 3mm, b = 12mm$, 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 overall capacitance 'C'

b. Plot the electric field variation with respect to the radius $('E_r'\ v/s\ 'r')$ if $E_{r_{max}} = 100\ V/m$. **(Use the graph sheet provided)** ***(04)***

3A. With a neat diagram, derive the mathematical model of a piezoelectric transducer when connected to an ideal charge amplifier. Further comment on its output variation according to variation in the frequencies of the input signal. ***(03)***

3B. Inserting a resistance $\boldsymbol{R_3}$ in parallel with capacitance $\boldsymbol{C}$ in the high pass filter shown in **Fig. Q3B** 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. ***(03)***

3C. A dual OPAMP instrumentation amplifier shown in **Fig. Q3C** 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. Consider a 4 bit binary weighted D/A converter having the circuit components defined as $R = 10K\Omega$; $R_f = 5K\Omega$ and $V_{ref} = -10V$. For an input binary word of 1101, determine the following:

a. Resolution

b. Input current

c. Output voltage ***(03)***

4B. 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)***

4C. With neat diagram, explain the operation of analog signal isolation using the magnetic medium. Highlight the importance of signal modulators as well as signal demodulators in the process. ***(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, its conditioning as well as its display. ***(04)***

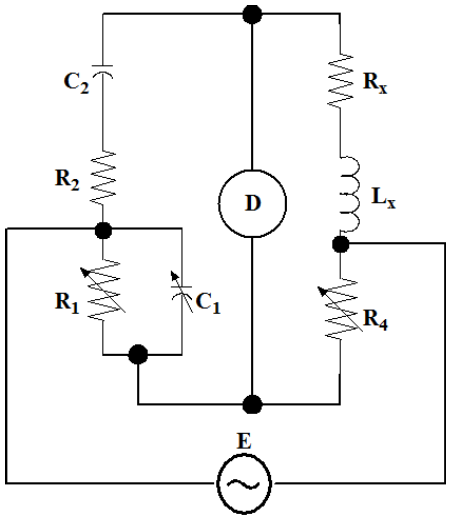

Fig. Q2A

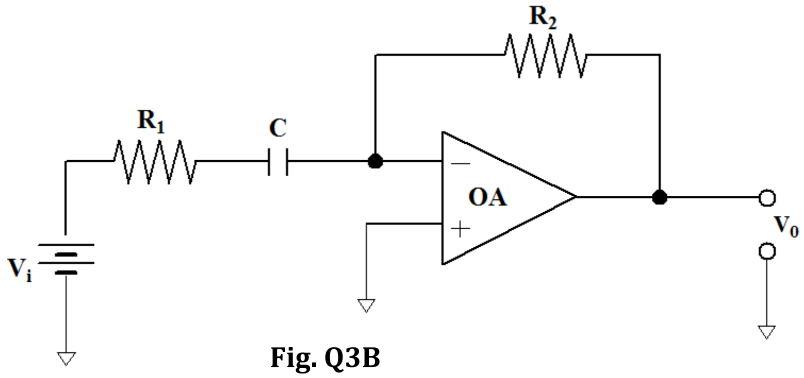

Fig. Q3B

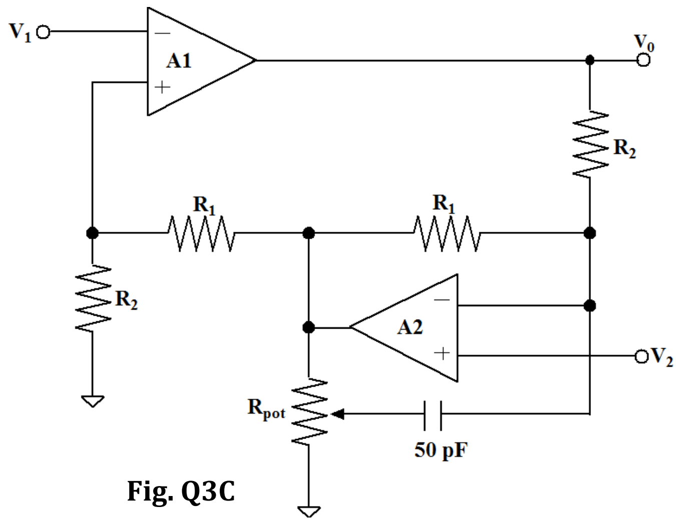

Fig. Q3C

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	