Reg. No. | | | | | | | | |

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

I SEMESTER M.TECH (ESM/PED) MAKE UP EXAMINATIONS, JAN 2018
SUBJECT: INSTRUMENTATION IN ELECTRICAL SYSTEMS [ELE 5105]
REVISED CREDIT SYSTEM

Time: 3 Hours | **Date: 4th January 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. 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. ***(03)***

1B. The discharge of a Venturimeter was found to be constant for rates of flow exceeding a certain value. Show that for this condition the loss of head due to friction in the convergent parts of the meter can be expressed as KQ^2 m where K is a constant and Q is the rate of flow in m^3/s.
Obtain the value of K if the inlet and throat diameter of the Venturimeter are 0.102m and 0.05m respectively and the discharge coefficient is 0.96. ***(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. ***(04)***

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.

2A. Mention any four main functions of signal conditioning circuit. 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 $1\mu A/{}^0K$. ***(03)***

2B. 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)***

2C. An active filter is employed as shown in **Fig. Q 2C**. With detailed steps, derive its mathematical model. From the analysis, comment on the type of the filter architecture (band pass/band reject/low pass/high pass) employed. Also determine the cutoff frequency and comment whether the filter architecture is suitable for employment in a signal conditioning unit that processes transduced signals of a structure undergoing seismic excitations. (Excitation frequency range of 0.01-40 Hz). ***(04)***

3A. Derive the mathematical model of a band pass active filter depicted in **Fig. Q 3A.** 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:

$R_1 = R_2 = 10K\Omega$; $R_{f1} = R_{f2} = 100K\Omega$; $R_L = R_H = 10K\Omega$; $C_L = 1\mu F$; $C_H = 10\mu F$ ***(03)***

3B. If $R_1C_1 = R_2C_2$ in the circuit shown in **Fig. Q 3B**, derive its mathematical model. Further, specify the component values to obtain a gain of 20dB at 100Hz. ***(03)***

3C. With neat diagram, describe how the linear motion of the core of an inductive transducer is transduced to electrical signals.

The output of an LVDT is connected to a 5V voltmeter through an amplifier having an amplification factor of 250. An output of 2mV appears across the terminals of LVDT when the core moves through a distance of 0.5 mm. Calculate the sensitivity of the LVDT and that of the instrument. The milli-voltmeter scale has 100 dvisions. The scale can be read to 1/5 of a division. ***(04)***

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

4B. With a neat diagram, explain the working of a binary weighted digital-analog converter. For a reference voltage of 5V, create a table of analog voltage output of a 4 bit binary weighted digital-analog converter. Let $R = 100K\Omega$, $R_f = 400K\Omega$. ***(03)***

4C. With the help of the basic ladder logic, explain the operation of an UP counter in ensuring the DETERMINISTIC nature of an industrial process.

Fig. Q 4C depicts a typical automated product packaging process. Once, the employed photoelectric sensor (X0) detects 10 products on the conveyer belt, the robotic arm (Y0) automatically packs the product carton placed at the end of the chain. The whole packaging process is reset upon the successful packaging of every batch of 10 products. With appropriate ladder logic, explain the proposed solution to achieve the above stated aim. ***(04)***

5A. With neat block diagrams explain the concepts involved in signal measurement and instrumentation related to an ECG measuring system ***(03)***

5B. With neat schematics, explain the Bit fields of Standard CAN and Extended CAN. Explain the concept of Arbitration in CAN based data transmission. ***(03)***

5C. With a neat diagram and accompanying waveforms of input current, switching current and explain the working of an ideal Boost converter. ***(04)***

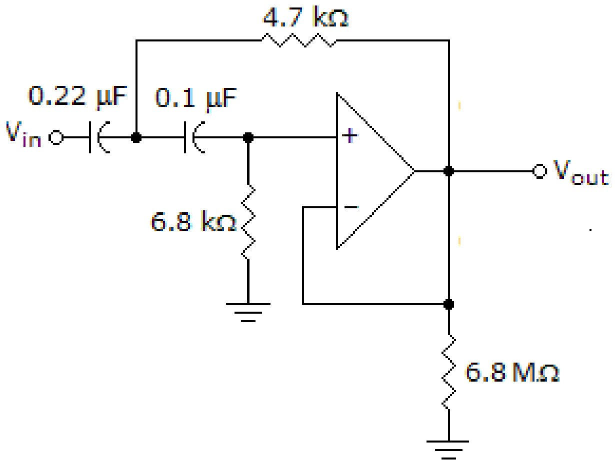

Fig. Q 2C

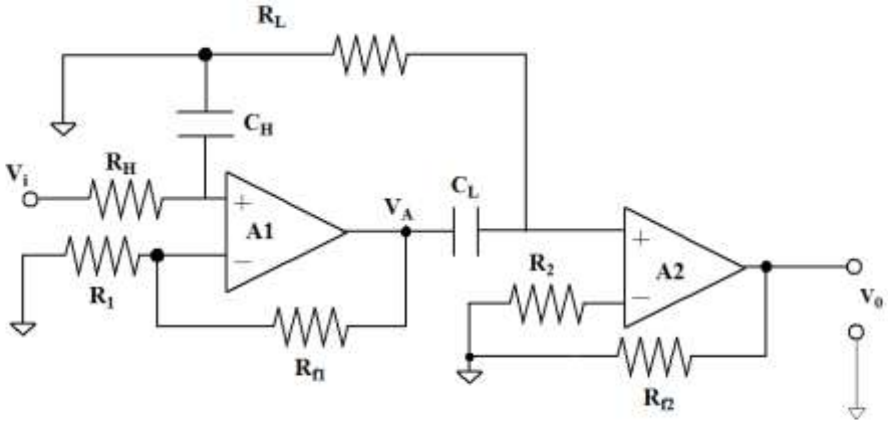

Fig. Q 3A

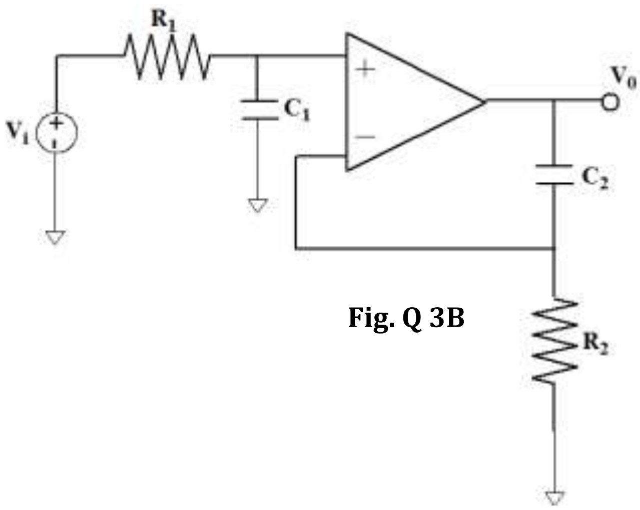

Fig. Q 3B

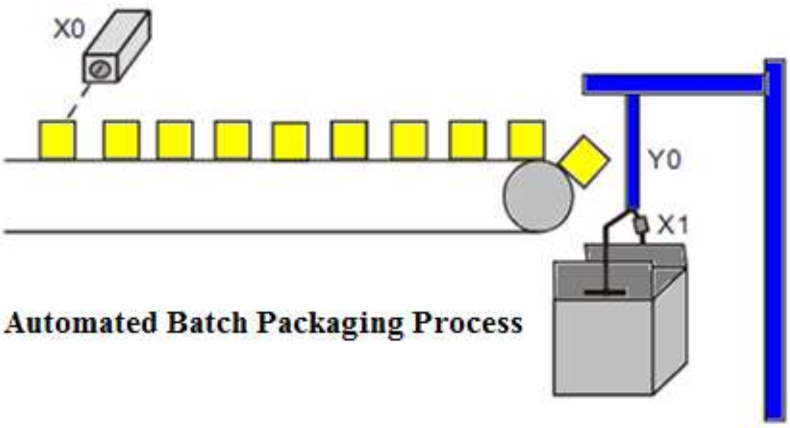

Fig. Q 4C

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	