Reg. No.									

MANIPAL INSTITUTE OF TECHNOLOGY

MANIPAL

(A constituent unit of MAHE, Manipal)

V SEMESTER B.TECH (ELECTRICAL & ELECTRONICS ENGINEERING)
PROCTORED ONLINE MAKEUP EXAMINATIONS, FEBRAUARY 2022

MEASUREMENTS & INSTRUMENTATION [ELE 3153]

REVISED CREDIT SYSTEM

Time: 3 Hours **Date: 24 February 2022** **Max. Marks: 20**

Instructions to Candidates:

- Answer **ALL** the questions.
- Missing data may be suitably assumed.

1A. The schematic of a tentative capacitive based displacement measurement system is as shown below in **Fig. Q1A**. Consider the reference input to the measurement system as well as the subsequent A/D converter (12 bit) to be the same DC input. The maximum value of observed capacitive change is $\pm 5\%$.

- Through appropriate analysis, compute the required gain of the differential amplifier such that the full range of the A/D converter is used effectively for further specifications of an application.
- Design a suitable 3 – OPAMP based instrumentation amplifier to replace the differential amplifier in the schematic which will still provide the same value of the gain determined earlier.

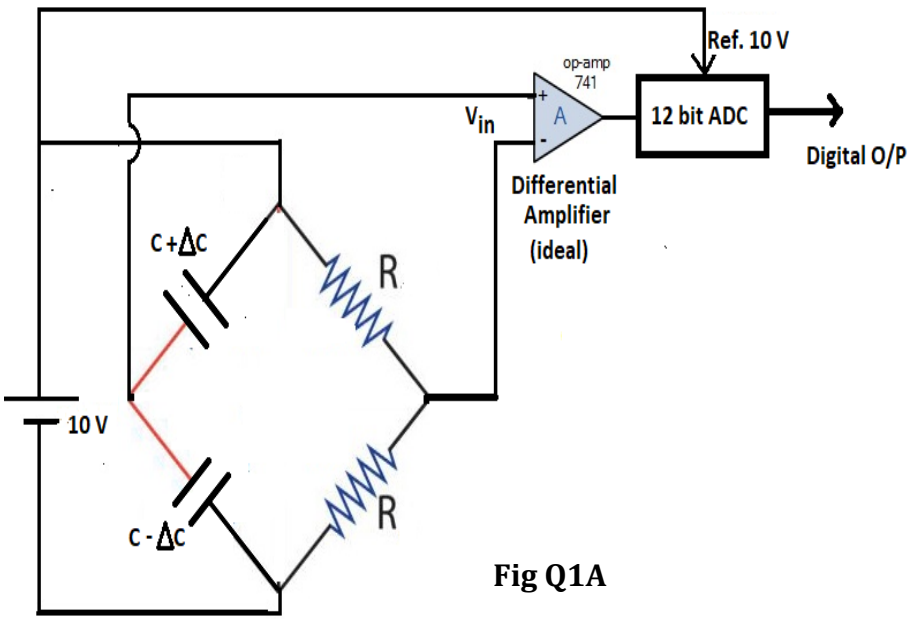

Fig Q1A

(05)

1B. The parallel resistance-capacitance bridge shown in **Fig. Q1B** has $C_1 = 0.1\ \mu F$ and $R_3 = 10\ k\Omega$. The bridge is balanced at a supply frequency of 100 Hz for $R_1 = 375\ k\Omega$, $R_3 = 10\ k\Omega$ and $R_4 = 14.7\ k\Omega$. Determine the dissipation factor of the parallel combination of C_p and R_p. ***(03)***

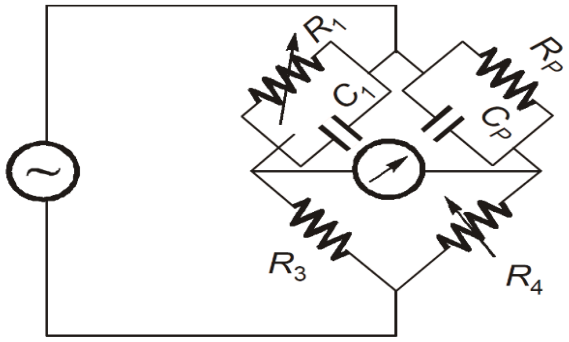

Fig Q1B

1C. Four ammeters M1, M2, M3 and M4 with the following specifications are available for measurements in a laboratory setup:

Instrument	Type	Full scale value (A)	Accuracy % of FS
M1	$3\frac{1}{2}$ digit dual slope	20	± 0.10
M2	PMMC	10	± 0.20
M3	Electrodynamometer	5	± 0.50
M4	Moving iron	1	± 1.00

A current of 1 A is to be measured. Through appropriate calculations, justify which instrument has the least error. ***(02)***

2A. The block schematic shown in **Fig. Q2A** is that of speed control of a small DC motor for the regulated flying objective of a Quadcopter. According to the transduced signal from the encoder, the control algorithm written in the microcontroller generates the required digital train of pulses which needs to be converted to their analogue equivalent so as to drive the control circuits which in turn regulate the speed of the motor. With appropriate justification, mention which of the following two D/A converters is preferred for this application:

- Binary weighted D/A converter and
- R-2R Ladder D/A converter

With a neat sketch, explain the working of a 4 – bit R-2R D/A converter for an input pulse train of 0101. Consider the reference voltage to be 10 V while $R = 10k\Omega$. Through appropriate calculations, determine the values of the following parameters:

- Current flowing into the analog ground
- Developed output voltage ***(05)***

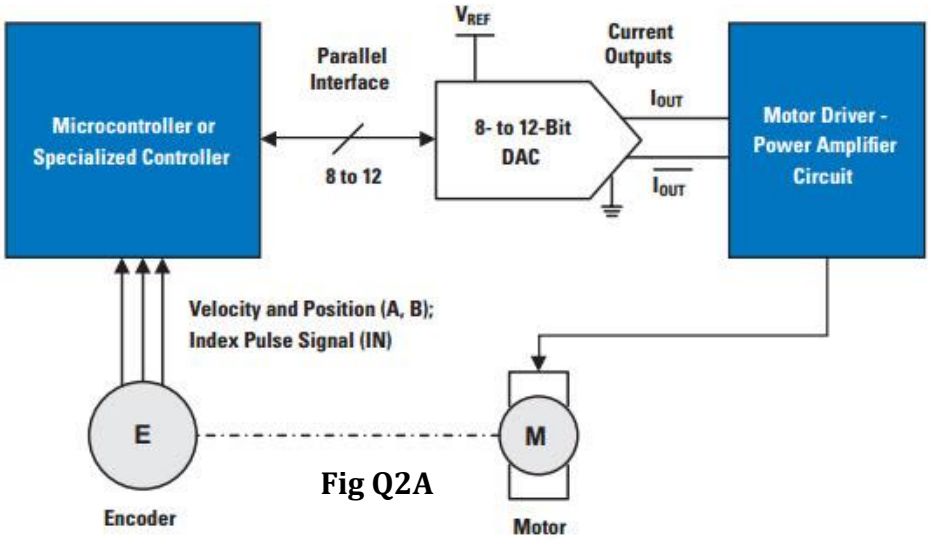

Fig Q2A

2B. A no-load test was performed on a three-phase induction motor. Two-wattmeter method was used to measure the 3-phase input power. The wattmeters have an electrodynamometer type of construction. The results of the conducted test are as follows: V = 400 V ± 1%, I = 3.25 A ± 1%, W_1 = – 600 W ± 2% and W_2 = 850 W ± 1%. Power factor is calculated using these measurements. Accordingly, calculate the power factor in the worst-case error scenario. ***(03)***

2C. A new car is equipped with a tyre pressure monitoring system (TPMS) that uses piezoelectric transducers installed inside the 4 tyres. The dimension of each transducer is 6 mm × 6 mm × 1.3 mm. The charge sensitivity and the dielectric constant of the transducer are given as 160 pC/N and 1250×10^{-11} F/m respectively. If each transducer is subjected to a force of 6 N, calculate the voltage generated in it and the deflection caused to its surface. The Young's modulus of elasticity of the material is given as 12×10^6 N/m^2. ***(02)***