AE 242 Aerospace Measurements Laboratory **SET - 4**

Mid Semester Exam 1st March 2021 17:45-19:45 Marks 55

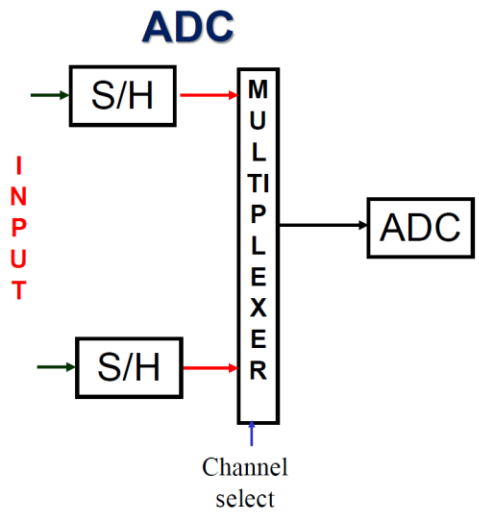
Instructions:

a) Submit your roll number and question paper SET (Right top) in the Google form. Link for the Google form is given on Moodle
b) Use ruled sheet for your answers. Try to avoid other side of page, sometimes during scanning back side written material reduces scanning quality.
c) Use black / blue ink pen.
d) On page 1 before starting your answers please write the following and sign "I will not make calls / attend calls / chat sessions and will not entertain any queries from 17:45-20:00 hrs. I shall report if anybody tries to contact me during the exam. I shall be available if instructor wishes to contact."
e) Write page number on each sheet in increasing order
f) End time of the exam is 19:45, stop writing at or before 19:45 and prepare for scanning.
g) A Moodle link will be available for submission of scanned pages up to 20:00 Hrs.
h) Retain your answer sheets till the evaluation is completed.
i) You can quote any figure from the lecture slides if it is needed. If you wish to quote please use the following notation, file name as given on MS Teams and slide number.

Q1) Ganpathi is working on designing a OpAmp circuit to match the input and output as given in A). Output of this OpAmp is given as input to two channel ADC as shown below. ADC range is 0 digital value for 0V to and to 500 digital value for 5.0V, conversion time is 1 second, initial value of ADC is 0.

A) Design and draw a OpAmp circuit for him which will map 0.2V and 2.5V input to 0.0 V and 5.0V output. (5)

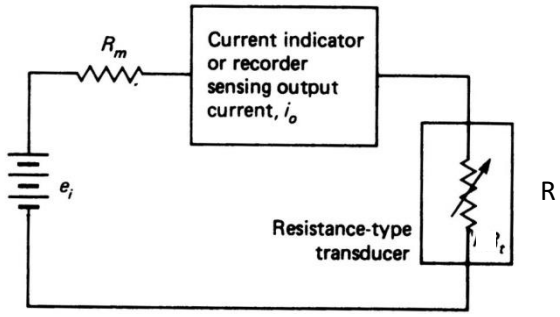
B) Input signal to OpAmp is shown below, X-axis is time in seconds and Y-axis is in volts. Output of the OpAmp is given as input to a two channel ADC configuration as shown below. Both the sample and hold are triggered at same instant. Draw an appropriate chart and plot the ADC values for the given input signal. You can separate two plots by shifting channel two slightly above or below from channel one and mark digital values wherever it is required. (10)



Q2) Javed is using a current indicator to measure temperature using the circuit given below. Relationship between the temperature and resistance is linear and it is given as $R = R_0 + kT$. Where, $R_0 = 0.1$ ohm, $k = 150$ ohm/degree centigrade and T is temperature in degree centigrade. Resistance R_m of current indicator = 0.1 ohm, supply voltage e_i is 10 V. Show your calculations.

A) What will be current when temperature is 45 degree centigrade? (2)

B) What will be error in measurement if current indicator resistance is considered as 0.2 ohms? (2)



Q3) Input to an angular speed measurement sensor is shown below. X-axis is time in seconds and Y axis is angle in degrees. Behavior of this sensor is modeled as first order system. Time constant (τ) of this sensor is 0.25 sec and Gain (K) is 0.22V/deg. Determine the value of sensor output at 5 sec, 10 sec, 15 sec and 20 sec. Write the formulae used for determining the sensor output and its justification for using the particular formula. You can assume that transient effects will be almost zero after 5 time constants. (8)

4) What is gage factor? Why it is important in strain measurement? (3)

Q5) Covert a) 25.125 (decimal number) to binary number. b) Two's complement of -41. Show your calculations. (3)

Q6) Explain difference between hysteresis and dead zone using suitable example. (4)

Q7) An accelerometer whose behavior is like a second order system is used for measurement of vibration. It is recommended to have damping ratio of 0.7. Will there be any significant change in output, If the damping is greater or less than 0.7? If yes justify your answer using appropriate figure from the lecture slides. (3)

Q8) A force f of 10 N is applied perpendicular to torque wrench plane at L_f =50 cm. Assume all the strain gages have 120Ω resistance and gage factor 2. Resistance of the strain gage material is sensitive to temperature. Change in resistance of strain gage due to temperature is $\Delta R = 4\Delta T \times 10^{-7}$, ΔR is in ohms and ΔT is temperature difference in degree centigrade from room temperature. Strain gages are fixed at length L and 3L, where L= 10 cm. Strain produced at the surface $\varepsilon_s = M \times 10^{-6}$, where M is moment in N-m. (3+4+3+5)

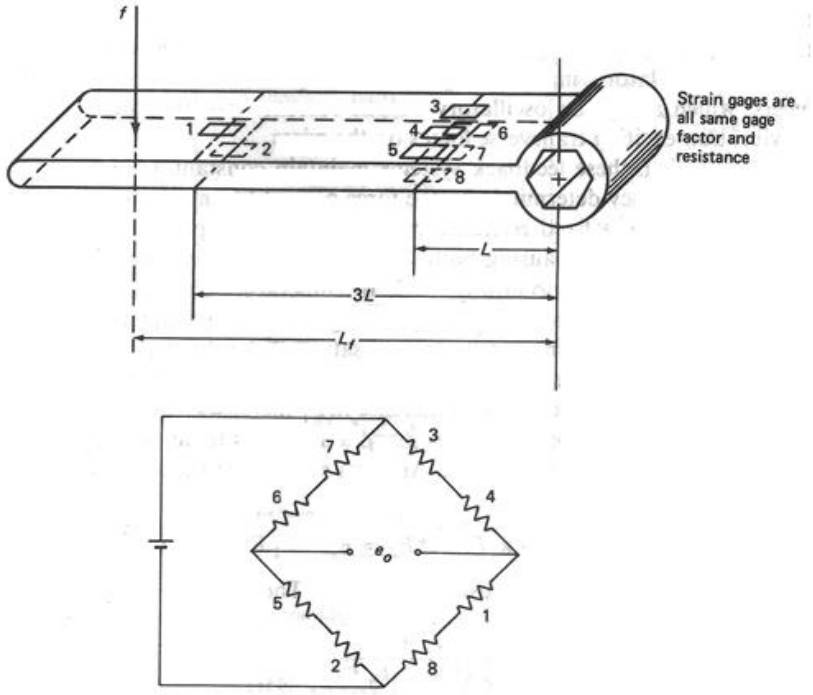
i) What will be output e_0 when supply voltage is 10 V. Temperature of all the strain gage is at room temperature.

ii) What will be the output if above force f is at 20 degrees from vertical? Strain due to axial load is $\varepsilon_s = F \times 10^{-6}$, where F is axial load. Temperature of all the strain gage is at room temperature.

iii) What will be the output when the temperature of all the strain gage increases by 10 degree centigrade from room temperature. Load f = 10 N is perpendicular to wrench plane.

iv) Top surface temperature of the wrench is 20 degree higher than the normal temperature. Bottom surface is at room temperature. What will be the output when perpendicular force f = 0 and perpendicular force f=10 N?

Write all the expressions to support your answer. Defines all the symbols / notations used by you.



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