INDIAN INSTITUTE OF SPACE SCIENCE AND TECHNOLOGY

Date: 01 Apr., 2022 Time: 1 Hour Total Marks: 20 No. of Students: 79

Quiz-2 (9.00 am to 10.00 am) Dept. of Avionics

Sub. No. **AV222**, Sub. Name: **INSTRUMENTATION AND MEASUREMENT**

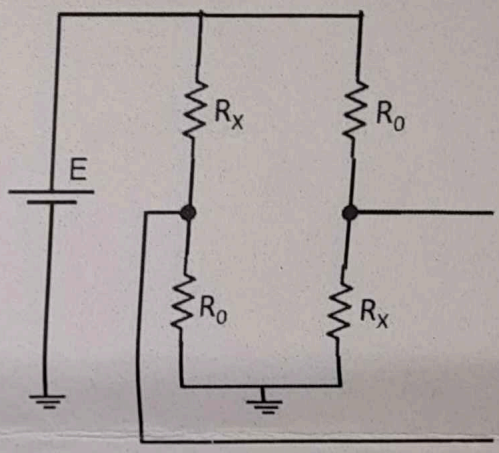
2nd year B. Tech ECE and EP Students, *Answer All Questions*

Q. 1. (4 Marks)

(a) Draw the circuit of a precision full-wave rectifier (having reduced effects of slew rate). Plot the waveforms at four important nodes of this circuit when its input (V_{IN}) is a 200 Hz sine wave. Assume ideal opamps and diodes of cut-in voltage of 0.5 V. (2)

(b) Make suitable modifications to the above circuit so that it will output the RMS value of V_{IN}.

Q. 2. Figure shows a bridge-circuit having 2 sensor elements [R_X] and 2 fixed elements [R_O]. R_X obeys the equation $R_X = R_O(1+X)$, where X is the measurand. (4 Marks) (2)



(a) Find the expression for differential signal and common-mode-signal present in the output of the bridge.

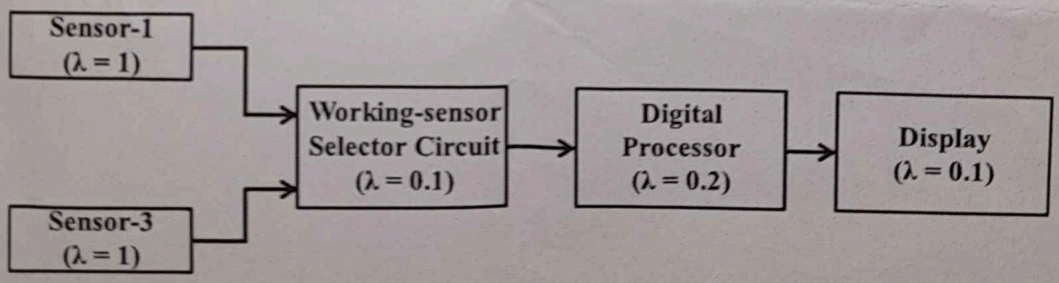
(b) A 3-opamp instrumentation amplifier (IA) needs to be used for processing the bridge output. Determine the minimum value of CMRR (in dB) of IA that will ensure that error in its output is less than 0.2 % for $X = 0.01$.

Q.3. (6 Marks)

(a) Draw the schematic of a compensated wattmeter. Label its important parts. (3)

(b) Determine the reading displayed by a 0 - 1 mA, 100 Ω PMMC meter when exposed to an input current $I = |\sin \omega t|$, where $\omega = 1000\pi$ rad/s. Hint: $|y|$ stands for absolute value of y.

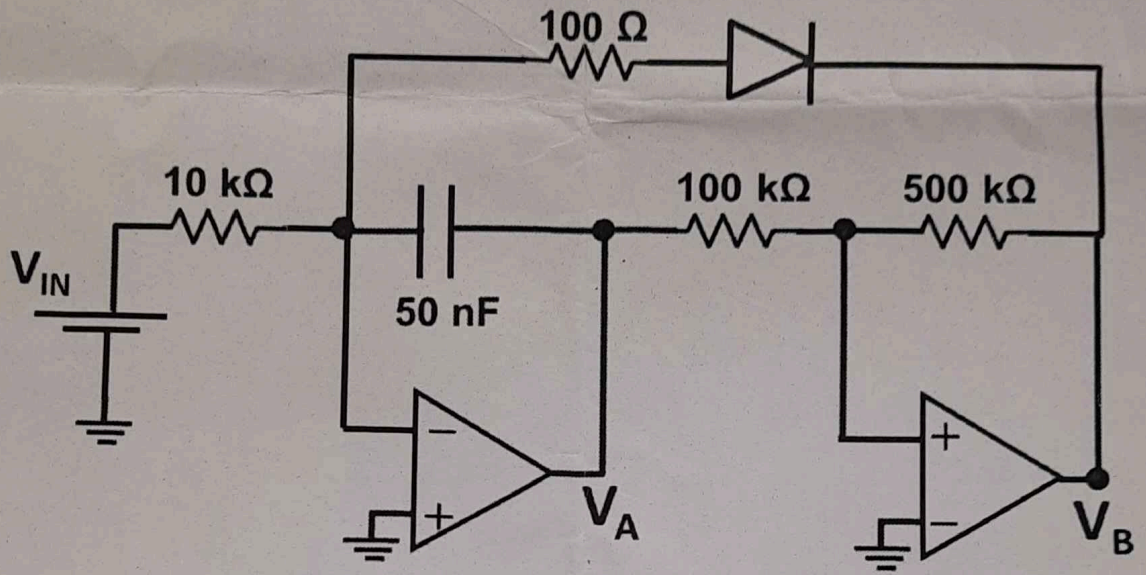
(c) Assume 1000 units of instrumentation-system shown in the figure are fabricated. How many of them will survive an operating period of 2 years? Failure-rates given in the figure are in the units of year^{-1}.



Q. 4. Consider the circuit in the figure below. Assume opamp supply voltages as ± 5 V. (6 Marks)

(a) Show that the frequency of the signal, V_B is proportional to the input voltage, V_{IN}. Find the proportionality constant. Make suitable assumptions, if required.

(b) Draw the (approximate) waveforms of the voltages V_A and V_B when V_{IN} = + 1 V. Mark the amplitude and relevant time-durations of these waveforms.



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