Seat No.: _____ Enrolment No._____

GUJARAT TECHNOLOGICAL UNIVERSITY

M. E. - SEMESTER – II • EXAMINATION – WINTER • 2014

Subject code: 1720302 Date: 03-12-2014

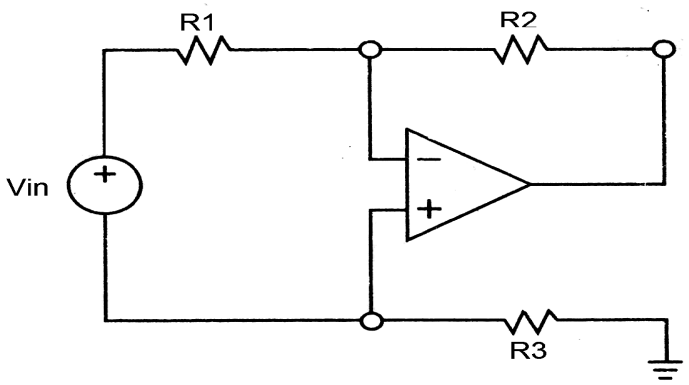
Subject Name: Advance Instrumentation

Time: 02:30 pm - 05:00 pm Total Marks: 70

Instructions:

1. **Attempt all questions.**
2. **Make suitable assumptions wherever necessary.**
3. **Figures to the right indicate full marks.**

Q.1 For the circuit shown in following figure derive the equation of feedback factor ɓ. **14**



Consider R1=30KÝ, R2=20KÝ, R3=10KÝ, r_d=150KÝ, and r_o=75Ý, evaluate the feedback factor ɓ.

Q.2 **(a)** Design a variable voltage source for the range of -10V to +10V using a 741 op amp, 100KÝ potentiometer, and dual ± 15V regulated power supply. What is the need of op amp in your design? **07**

(b) Derive the equation of close loop gain of inverting amplifier. **07**

OR

(b) Derive the equation of input resistance of inverting amplifier. **07**

Q.3 Strain gauge bridge is cascaded by instrumentation amplifier of gain A. Strain gauges are mounted in all four arms of the bridge. It has calibration facility against reference voltage (V_{REF}) and strain gauge tolerances. Draw the circuit diagram showing all components and derive the equation of output voltage v_o from instrumentation amplifier. What is the advantage of using strain gauges in all four arms? **14**

Let the strain gauge in your design be 100 ± 1% types. Limit maximum current through strain gauges to 20mA to avoid excessive self heating. Assume V_{REF}=15V ± 5%. Specify suitable values for resistors connected for calibration purposes. Outline the calibration procedure.

OR

Q.3 **(a)** The transducer Pt RTD is connected to one of the arm of the transducer bridge. Bridge is cascaded by instrumentation amplifier of gain A. Draw the circuit diagram showing all components and derive the equation of output voltage v_o from instrumentation amplifier. **10**

Consider reference supply of 15V. Find the bridge resistance values and A to achieve an output sensitivity of 0.1 V/ºC near 0 ºC. To avoid self heating limit the power dissipation of RTD to less than 0.15mW. Compute v_o for 90ºC.

(b) Discuss high sensitivity I to V converter and derive the equation of output voltage v_o. **04**

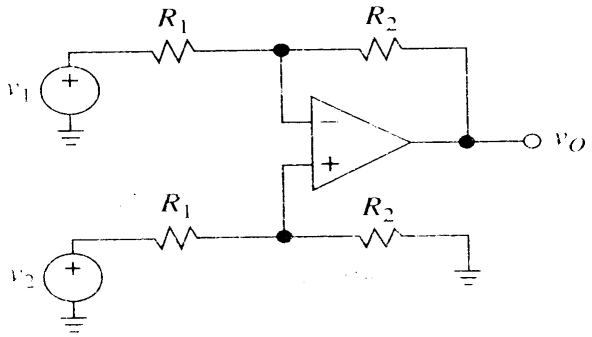
Q.4 Draw the circuit diagram of low pass KRC filter and derive the equations for gain, γ_0 and Q-factor. **14**
Using equal component design specify elements for a second order low pass filter with f_0=2KHz and Q=5. What is the dc gain of this design?
Modify this circuit for a dc gain of 0 dB.

OR

Q.4 Draw the circuit diagram of band pass KRC filter and derive the equations for gain, γ_0 and Q-factor. **14**
Using equal component option design the filter with f_0=1KHz and BW=100Hz. What is the resonance gain of this design?
Modify this circuit for a resonance gain of 20 dB.

Q.5 **(a)** Explain noise power density, spectral noise density, and white noise in detail. **07**

(b) The difference amplifier shown in following figure uses 741 op amp and a perfectly matched resistance set with R1=10KÝ and R2=1000KÝ. Suppose the inputs are tied together and driven with a common signal v_I. Estimate the typical change in v_o if (i) v_I is slowly changed from 0 to 10V, and (ii) v_I is a 10KHz, 10V peak to peak sine wave. Consider $CMRR_{dB}$ (10KHz) = 57dB. **07**



OR

Q.5 **(a)** What do you mean by input bias and input offset current? Derive the equation of error voltage generated due to the input bias current and input offset current for the resistive feedback op amp circuit. What are the ways to reduce this error voltage? What are the consequences of these ways? **07**

(b) A 741 op amp with ±15V supplies is configured as a non inverting amplifier having a gain of 5 V/V. (a) If the ac input amplitude is Vim=0.5V, what is the maximum frequency before the output distorts? (b) If f=10KHz, what is the maximum value of Vim before the output distorts? (c) If Vim=40 mV, what is the useful frequency range of operation? (d) If f = 2KHz, what is the useful input amplitude range? **07**

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