inkPhysics

QUESTION WORKBOOK

Summing and difference amplifiers

Electronics · Year 13

AQA 3.13.2

17 questions · 52 marks

PRINT EDITION

SECTION A · Warm-up

A1 Explain why a summing amplifier does not simply add its input voltages. [2]

A2 State the two facts about the summing point of an inverting amplifier that carry the derivation marks. [2]

A3 Write down the equation for the output of a difference amplifier, and state the order in which the two operations must be carried out. [2]

A4 Explain how a difference amplifier removes interference picked up on the leads of a sensor. [2]

A5 State what happens to the output of a summing amplifier when the equation asks for a voltage larger than the supply rails, and state the check a designer should always make. [2]

A6 State what limits the accuracy of a weighted-resistor digital-to-analogue converter, and state how accurate each resistor weight must be. [2]

SECTION B · Standard

B1 A summing amplifier has R_f = 100 kΩ. Its three inputs are 0.20 V through 100 kΩ, 0.30 V through 50 kΩ and 0.10 V through 20 kΩ. Calculate the current from each input and the output voltage. [3]

B2 A summing amplifier has R_f = 47 kΩ, with V_1 = 0.50 V through R_1 = 47 kΩ and V_2 = -0.25 V through R_2 = 4.7 kΩ. Calculate the output voltage. [3]

B3 A 4-bit weighted-resistor DAC uses R_f = 10 kΩ with input resistors of 10, 20, 40 and 80 kΩ from the most significant bit downward, and logic 1 = 5.0 V. Calculate the step size and the magnitude of the output for the input 0110. [3]

B4 A difference amplifier with R_f/R_1 = 50 has V_+ = 3.4120 V and V_- = 3.3800 V. Calculate the output voltage. [3]

B5 Two leads from a sensor arrive at a difference amplifier of gain 200. The wanted signal is a difference of 12 mV between them, and each lead also carries an identical 0.25 V of mains hum. Calculate the output, and state the contribution the hum makes to it. [3]

B6 A summing amplifier gives gains of 3 and 5 to its two inputs and saturates at ±13 V. Determine the output when $V_1 = 1.0$ V and $V_2 = 2.4$ V, and the largest V_2 the amplifier can handle linearly with V_1 held at 1.0 V. [3]

B7 A 4-bit weighted-resistor DAC has a step size of 0.625 V. Calculate its full-scale output and state the number of distinct output levels. [2]

SECTION C · Stretch

C1 An 8-bit weighted-resistor DAC uses R_f = 10 kΩ, logic 1 = 5.0 V, and 10 kΩ as the input resistor of the most significant bit, each successive bit's resistor being double the one before. Calculate the resistance of the least significant bit's resistor, the step size and the full-scale output, then determine the accuracy each resistor weight needs if the staircase is to stay correct to within half a step, and comment on the practicality of the design. [7]

C2 An audio mixer is built round a summing amplifier with R_f = 100 kΩ and must give voltage gains of 1, 2 and 5 to its three channels. Calculate the three input resistors, and calculate the output at an instant when the channel inputs are 0.10 V, 0.15 V and 0.02 V. [4]

C3 A strain-gauge bridge sits balanced with both midpoints at 2.5000 V. Under load one midpoint rises to 2.5085 V while the other stays put. A difference amplifier built with R_1 = 1.0 kΩ is to give an output of 4.0 V under that load. Calculate the difference voltage, the gain needed and R_f, and state what would happen if the raised midpoint were fed to an ordinary inverting amplifier of the same gain instead.

[4]

C4 A sensor delivers 1.00 V at the bottom of its range and 1.50 V at the top. A summing amplifier with R_f = 100 kΩ is to convert this to 0 V at the bottom of the range and -5.0 V at the top, using the sensor through R_1 and a steady -1.00 V reference through R_2. Calculate both input resistors, and verify the output at each end of the range. [5]