BITS PILANI DUBAI CAMPUS
INSTR C364 ANALOG ELECTRONICS

II SEM 2009-10 **COMPREHENSIVE EXAMINATION** CLOSED BOOK

Total Marks : 70 Weightage: 35% Time Allowed: 3 hours
23 May 2010

INSTRUCTIONS

1. This paper contains **NINE (9)** questions and comprises of **FOUR (4)** pages. Answer **ALL** questions. Unless specifically stated, all symbols have their usual meanings.

1. For the diode circuit shown in Figure 1, both diodes are identical. The $I_D - V_D$ characteristic for each diode is given by

$$V_D = 0.6 + 0.011 I_D$$

where V_D is in Volts and I_D is in mA. Find the value of R for which the output voltage V is 80 mV. If one of the diodes becomes faulty and the voltage across R reads 0.586 V, what type of fault (open circuit or short circuit) has occurred and in which diode?

5+2

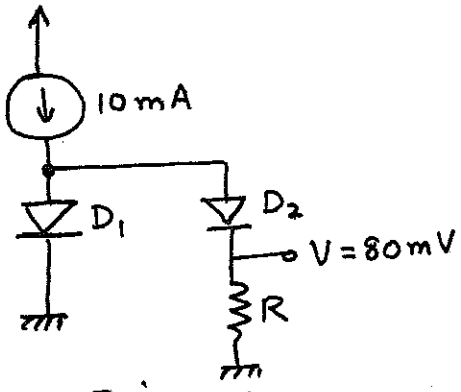

Figure-1

(7 marks)

2. For the circuit shown in Figure 2, determine the output voltage in terms of the input voltages v_1 and v_2. Assume ideal op amp. Hence choose appropriate values of resistors so that the circuit functions as a simple subtractor. What is the purpose of the resistors R_{c1} and R_{c2}?

4+1+2

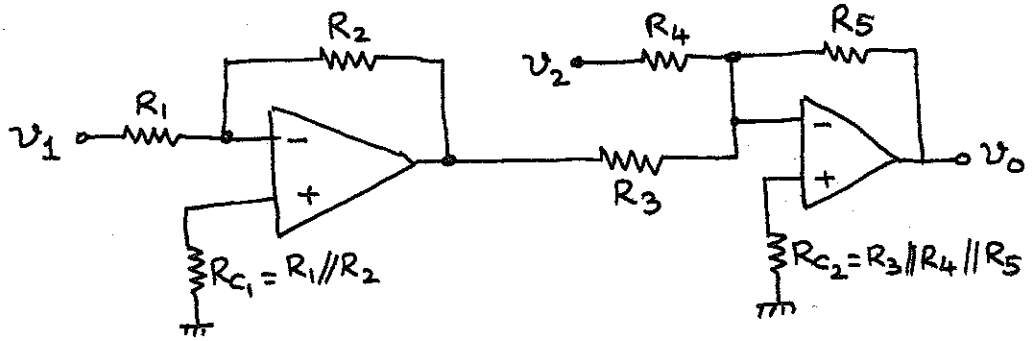

Figure-2

(7 marks)

3. An ideal inverting op amp circuit is used as a temperature–to-voltage converter using a transducer AD590 as shown in Figure 3. The transducer delivers a 1.0 μA/Kelvin current output, such that the current I_T through it is 273 μA at 0°C and 373 μA at 100°C. It is desired to make a Celsius Thermometer such that the output V_o of the opamp circuit reads 0 mV for 0°C and 100 mV for 100°C.

Note: Question No 3 continues on page 2.

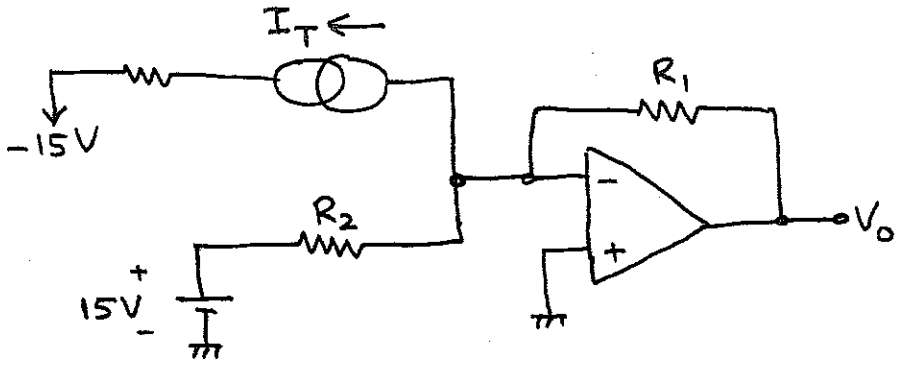

Figure - 3

(a) Determine the values of R_1 and R_2. (6 marks)

(b) You are asked to modify the circuit by adding a non-inverting summing amplifier that takes V_o as one of its inputs and a certain DC voltage as the other input. Suggest a design for the summing amplifier such that the overall output can be used as a Fahrenheit thermometer.

(8 marks)

4. Figure 4 describes a logarithmic amplifier. The base – emitter voltage V_{be} of the transistor determines the collector current I_c through the equation $I_c = I_s \exp[V_{be}/V_T]$. I_s is the reverse saturation current of the transistor and V_T is the thermal voltage (= 0.0258 V at room temperature). Express V_o in terms of V_{in}. What is the main drawback of this amplifier?

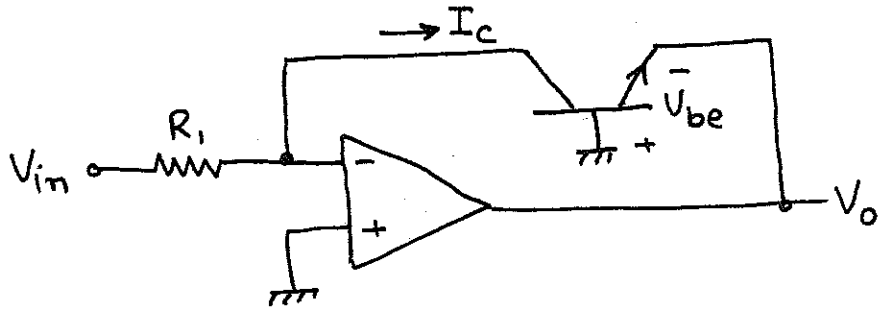

Figure - 4

(6 marks)

5. The logarithmic amplifier in Figure 4 is modified by using two such stages and adding a reference voltage V_{REF} as shown in Figure 5. Now express V_o in terms of V_{in}. What are the two main advantages of this modified logarithmic amplifier? If V_o is desired to be 50 mV when V_{in} is 1 V, what value of V_{REF} is to be used?

Note: Question No 5 continues on page 3

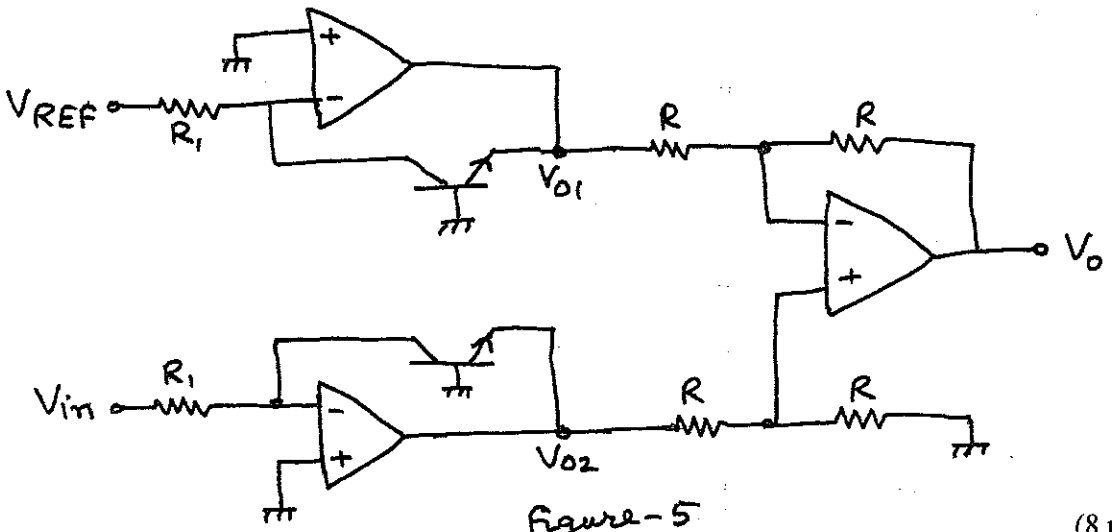

Figure-5

(8 marks)

6. The Wein Bridge oscillator circuit of Figure 6 has C = 0.001 μF and R_a = 10 kΩ. What range of values of R_b will make the oscillation frequency variable from 10 KHz to 50 KHz? What condition must be satisfied in order to sustain the oscillation?

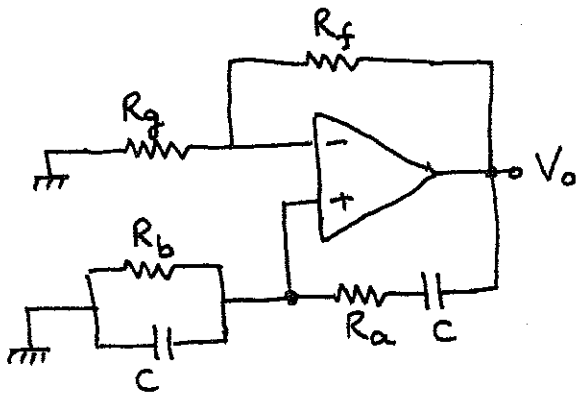

Figure-6

(8 marks)

7. Define the term percentage load regulation in a voltage regulator. A power supply having an output resistance 1.5 ohms supplies a full load current of 500 mA to a 50 ohm load.

(a) Determine the percentage voltage regulation of the supply. (3 marks)

(b) What is the no load output voltage of the power supply? (3 marks)

8. Define Total Harmonic Distortion. In a power amplifier, the output current (in mA) is related to the input voltage (in volts) by the equation

$$i_C = (2 + v_I)^3 - 5v_I^3$$

Assuming that a sinusoidal input $v_I = \sin(\omega t)$ [in volts] is applied, determine the following: (a) quiescent output current, (b) average output current, and (c) Total Harmonic Distortion.

(8 marks)

9. An ion sensitive field effect transistor is used for pH measurement. The change in response of the sensor for a unit change in pH is indicated through a Nernst factor given by

$$E = -[2.303 * (RT)/(nF)]$$

R is the standard gas constant 8.314 J/K, T is in Kelvin, n = 1 typically and F = Faraday constant = 96500 mol^{-1}. E is expressed in Volts / pH. The sensor response is however, such that its output is 0 mV for pH = 7

Draw the sensor response for all range of values of pH from 0 to 14 at 25 °C. How is the response affected if the temperature is increased to 70°C?

(6 marks)

The End

BITS PILANI DUBAI CAMPUS
INSTR C364 ANALOG ELECTRONICS - Test 2

Sem2, 2009 - 10 OPEN BOOK Time Allowed: 50 mins
Total Marks : 30 Weightage: 15%

INSTRUCTIONS

1. This paper contains **Four (4)** questions. Answer **ALL** questions.
2. Unless specifically stated, all symbols have their usual meanings.

1. Name the different types of distortions that can occur in a power amplifier. A certain power amplifier accepts an input signal $i_b = \sin \omega t$ and delivers an output $v_o = 4(1 + i_b)^3$ (in volts). Assume negligible output resistance for the amplifier. Calculate the average value of the output voltage.
What is the average power delivered to a load resistor R_L = 10 Ω,
(a) at the fundamental frequency ω,
(b) at the second and higher harmonic components?
Determine the total harmonic distortion in the amplifier output. **(10 marks)**

2. A 10-V zener diode is designed to operate at a maximum power of 2 W. The minimum current to keep the zener in the breakdown region is I_{zk} = 5 mA. The zener is used in a Voltage regulator circuit shown in Figure 1 where V_{in} can vary between 15 V and 20 V. The upper limiting value of R_s arises when the input supply voltage is minimum while the current through the zener is minimum and the load is switched on. The lower limiting value of R_s arises when the input supply is maximum, the zener takes in the maximum current and the load is switched off. Determine the range of values of R_s that can be used. If a value for R_s that is midway between these two limits is used, what is the maximum power that will be dissipated in the resistor? How much power is absorbed by the zener?
(8 marks)

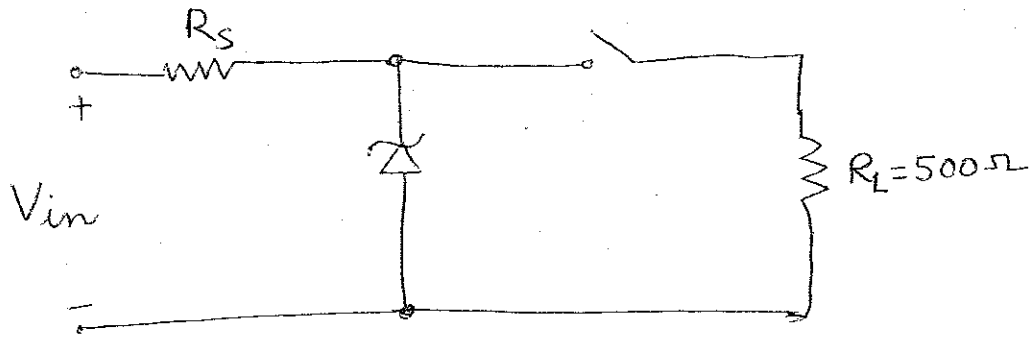

Figure - 1

3. A temperature compensating circuit is employed by connecting 3 Si diodes in series with a zener as shown in the Figure 2. The zener diode has a breakdown voltage of 10 V at 25 °C and a temperature coefficient of + 5.5 mV/°C while the temperature coefficient of each Si diode is -2.2 mV/°C. The forward voltage of the Si diode is 0.65 V. During a circuit application, the temperature rises from 25°C till 100°C at which point one of the silicon diode short circuits.

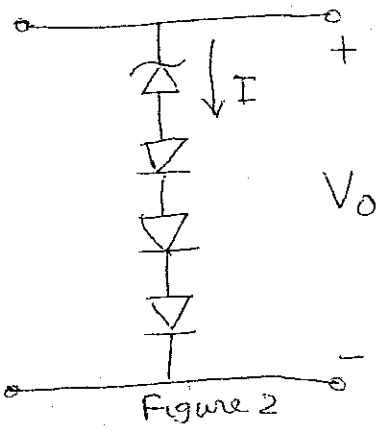

Figure 2

Determine how the output voltage will vary during the circuit application.

(6 marks)

4. The gain of a certain amplifier is given by $A(j\omega) = -16x\dfrac{10^6}{j\omega}$ A feedback path connected around it has a $\beta(j\omega) = \dfrac{10^3}{(2x10^3 + j\omega)^2}$. Will the system oscillate? If so, at what frequency? **(6 marks)**

The End

BITS PILANI DUBAI CAMPUS
INSTR C364 ANALOG ELECTRONICS - Test 1

Sem2, 2009 - 10 | CLOSED BOOK | Time Allowed: 50 mins
Total Marks : 30 | Weightage: 15%

INSTRUCTIONS

1. This paper contains **Five (5)** questions. Answer **ALL** questions.
2. Unless specifically stated, all symbols have their usual meanings.

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1. Assuming an ideal op amp, determine the output V_o for the circuit shown in Figure 1. Under what condition is the output V_o independent of the values of the resistors used in the opamp circuit? **(5 marks)**

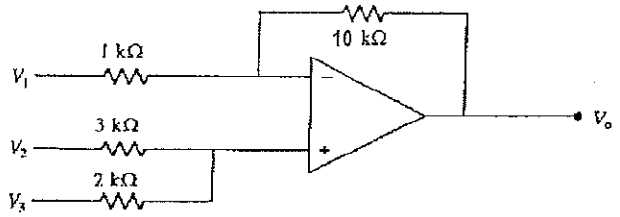


Figure 1

2. Draw the circuit diagram of an inverting integrator. Assume ideal opamp, R = 10 kΩ and C = 100 nF for the integrator. For a sinusoidal input, at what frequency is the output voltage equal in magnitude to the input voltage? **(4 marks)**

3. A 5V dc supply is connected across a series combination of a diode and a 5K resistor. The diode is forward biased. Draw the circuit arrangement. The voltage across the diode, V_D and the current through the diode, I_D are related through the diode equation

$$I_D = I_s \left[e^{(V_D / V_T)} - 1 \right]$$

where $I_s = 10^{-14}$ A and $V_T = 0.026$ V at room temperature. Determine V_D and I_D. **(8 marks)**

4. Define the offset parameters I^+, I^- and V_{os} for a non ideal op amp. The opamp in Figure 1 is found to be non ideal with $V_{os} = 1$ mV, $I^+ = I^- = 10$ nA. Redraw Figure 1 by showing these offset parameters. Hence calculate the output voltage that would be obtained when all the inputs are grounded. **(8 marks)**

5. A 10 V DC voltmeter is to be used to measure currents up to 10 mA in two ranges: 0 – 1 mA and 0 – 10 mA. Design an inverting opamp circuit with a range switch that is capable of measuring such currents using the voltmeter. Also estimate the feedback resistances needed. Draw the circuit and indicate how the voltmeter will be connected. **(5 marks)**

The End

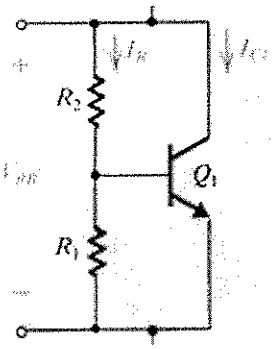
NAME: ID NO.

BITS PILANI DUBAI CAMPUS
INSTR C364 ANALOG ELECTRONICS - Quiz 2

Sem2, 2009 - 10 CLOSED BOOK Time Allowed: 15 mins
Total Marks : 15 Weightage: 5%

INSTRUCTIONS : Answer ALL questions

1. Consider a v_{BE} multiplier as shown in the figure that uses a transistor for which i_C = 1 mA when v_{BE} = 0.6V. Assume large β for the transistor. It is required to obtain a value of 1.2 V for V_{BB}. Given R1 = R_2 = 1 kΩ. Determine the bias current needed to supply the current to the multiplier. (5 marks)



2 A Class B power amplifier is modified as shown in Fig 1(a) by adding another amplifier of gain A_o = 100 V/V in a feedback loop. The two transistors are matched pairs and Q_N has characteristics as shown in Fig 1(b)

(a) Upto what value of the magnitude of input $|v_I|$ will the output be zero?

(b) Express the output voltage in terms of the input voltage and hence draw the transfer characteristic.

(c) What benefit does the circuit of Figure 1(a) have over a normal Class B power amplifier?

(d) For the power amplifier, if you are only given a single power supply of voltage $2V_{CC}$ instead of two power supplies $+V_{CC}$ and $-V_{CC}$, how will you modify the circuit of Figure 1(a) so that the same output v_o is obtained

(10 marks)

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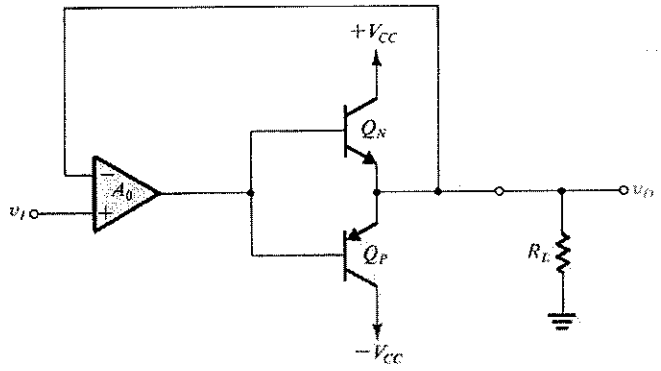

Figure 1(a)

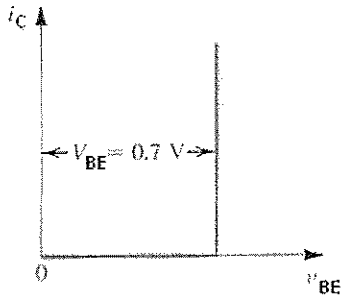

Figure 1(b)

The End

Name :
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SET A

BITS PILANI DUBAI CAMPUS
INSTR C364 ANALOG ELECTRONICS - Quiz 1

Sem2, 2009 - 10 | CLOSED BOOK | Time Allowed: 15 mins
Total Marks : 10 | Weightage: 5%

INSTRUCTIONS : Answer ALL questions

1. Realize log and antilog amplifiers using opamp, transistor and resistors. Show how log and antilog amplifiers can be used as a building block to obtain a output waveform $y = a^b$ where a and b are independent input waveforms.

(3 marks)

2. Using a waveform $V_i = \sin\omega t$ it is desired to produce a waveform $Vo = \sin 3\omega t$. Draw a schematic of a frequency tripler employing opamp multipliers and subtractors.

(4 marks)

3. Design a second order Butterworth VCVS Sallen Key low-pass filter for a cut off angular frequency $\omega_c = 200$ rad/s and gain = 5. Given $C_1 = C_2 = 1$ μF and $R_A = 1$ kΩ.

(3 marks)

The End