BIRLA INSTITUTE OF TECHNOLOGY & SCIENCE, PILANI

EEE F341/INSTR F341 Analog Electronics

Second Semester 2017-2018

Date: 07.03.2018 **MID-SEMESTER TEST (Open Book)** **MM: 70**

Note: Assume all op-amp as ideal with $V_{sat} = \pm 10$ V, if not mentioned in the question

1. **(a)** Design a non-inverting amplifier circuit to have input impedance of 500 kΩ and a gain of 100 for AC signal having bandwidth of 80 kHz. Assume f_H of amplifier is controlled by the dominant pole of the op amp used. Sketch and label the bode magnitude plot of the amplifier (use 500 kΩ in the feedback path, assume f_{3db}=100 Hz at open loop and open loop gain as 10^5) **[10]**

(b) Design an op-amp based differentiator circuit to show output as -5V when input changes from 0 V to 1 V in 10 µsec. The circuit should have an input impedance of 1 kΩ and a gain of 10. Sketch and label the bode magnitude plot of the circuit. Use bias current compensation in the design. (Assume f_{3db}=10 Hz at open loop and open loop gain as 10^5) **[10]**

2. **(a)** Design an analog circuit to find the solution of the following differential equation under the given conditions.

$$2\frac{d^2V}{dt^2} + 5\frac{dV}{dt} + V = 4$$

$$\text{at } t = 0, \frac{d^2V}{dt^2} = 2\ \text{V/s}^2 \text{ and } \frac{dV}{dt} = 1\ \text{V/s}$$ **[10]**

(b) Find the expression for V_0 for the circuit shown in **figure 2(b)**.(Q_1 and Q_2 are identical)**[10]**

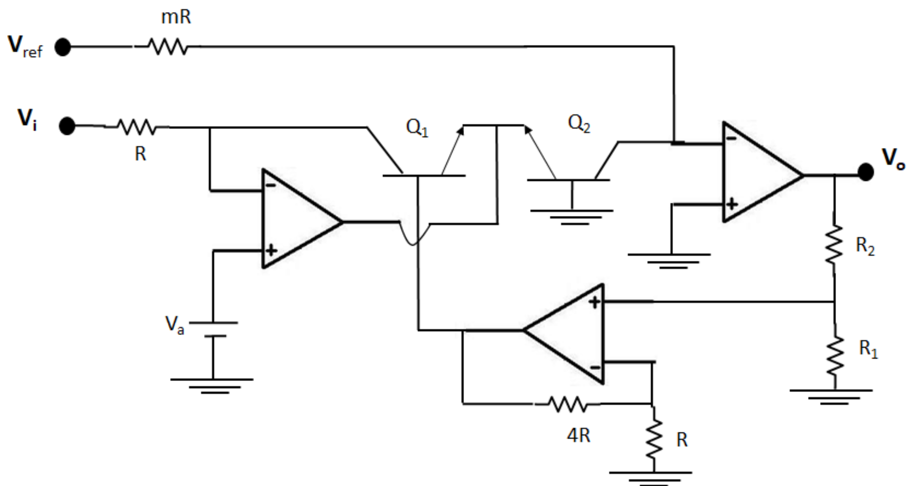

Figure. 2(b)

3. **(a)** Use the given bridge circuit shown in **figure 3(a)** to show a differential output voltage of 1V to measure a pressure exerted by putting a weight on the pan containing strain gauge G_1 to change its resistance by 0.4 Ω. Now extend the design to show output through a PMMC meter having internal resistance of 1kΩ and full scale deflection (FSD) as 100µA. (Use optimum number of active and passive components only) **[10]**

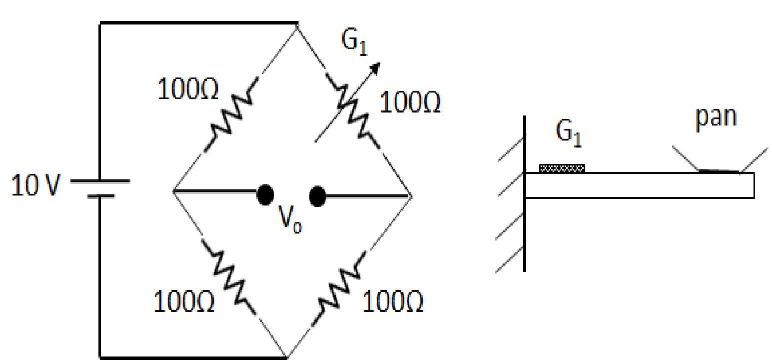

Figure. 3(a)

[P.T.O.]

(b) Find the transfer function of the circuit shown in **figure 3(b)** and identify the type of the filter. Calculate R_1 and R_3 of the circuit for Butterworth approximation when f_0 = 1kHz. Also sketch the bode magnitude plot of the filter. (consider $C_2 = C_4 = 0.1\mu F$) **[10]**

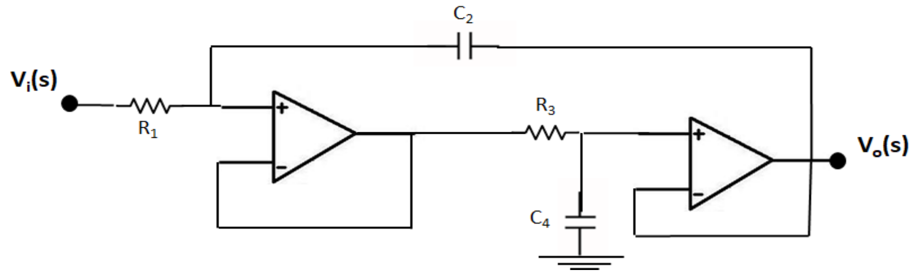

Figure. 3(b)

4. **(a)** Design a Sallen Key second order high pass Butterworth filter shown in **figure 4(a)** having 3dB frequency as 10 kHz. Use capacitance of 1.59 nF only and R_a=10kΩ. **[10]**

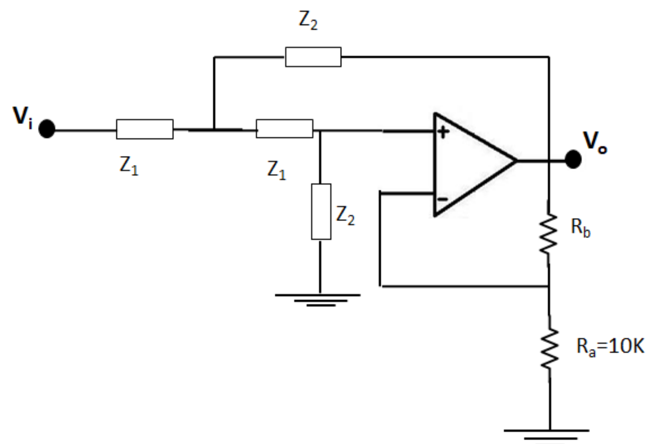

Figure. 4(a)

(b) For the circuit shown in **figure 4(b)**

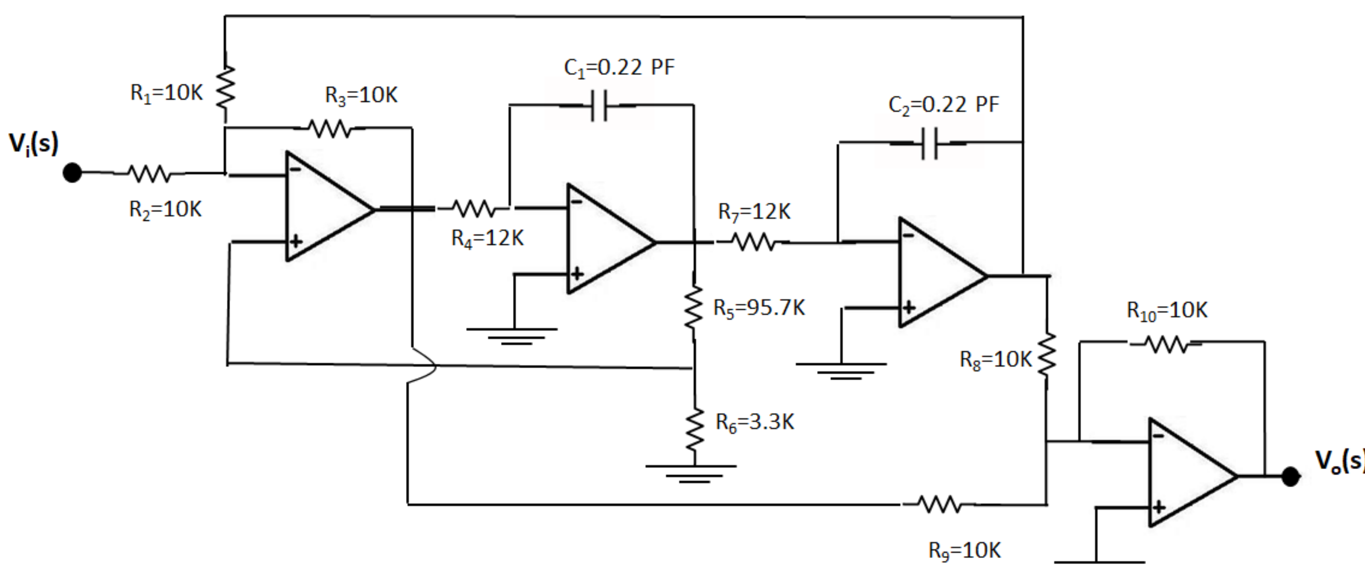

Figure. 4(b)

(i) Identify the type of filter
(ii) Find f_0
(iii) Find Q
(iv) Find the complete transfer function of the filter i.e. $V_o(s)/ V_i(s)$ **[10]**

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