EMEC/EMTR-2434 Assignment #2
Due: TBA

Q. 1 (Q4.21)

A pressure microsensor is tested by applying a pressure to it of 200 bar, measured by an accurate, calibrated reference pressure-measuring instrument. A set of 12 measurements are made as a reference set of measurements in order to assess the standard deviation and standard error of the mean for measurements made by the device. The measurements obtained for this reference set are given below.
199.7 202.0 200.9 195.7 200.2 199.9 204.4 198.0 203.1 199.1 200.5 196.9
When the microsensor is subsequently used in a workplace to measure the pressure in an enclosed vessel, a reading of 183 bar is obtained. What is the likely error in this measurement, expressed to 95.0% confidence limits?

Q. 2 (Q4.29)

In a foundry producing castings, the variance in the mass of a sample of 20 castings taken from a large batch is calculated to be 1.36 kg. Calculate the true variance of the mass for a whole batch of castings from which the sample was taken to (a) a 90% confidence level and (b) a 5% significance level.

Q. 3 (Q10.26)

(a) Show that the optimal coefficients $\hat{a}$ and $\hat{b}$ for a linear relationship $y = a + bx$ between a set of n measurements $y_1 \cdots y_n$ and $x_1 \cdots x_n$ are given by:

$$\hat{b} = \frac{\sum(x_i y_i) - n x_m y_m}{\sum x_i^2 - n x_m^2} \quad \text{and} \quad \hat{a} = y_m - \hat{b} x_m$$

where x_m and y_m are the mean values of x and y.

(b) The following set of measurements is obtained for values of an output variable y and an input variable x that are believed to be related by a linear expression of the form: $y = a + bx$.

i	1	2	3	4	5	6	7	8	9	10
x_i	40	45	50	55	60	65	70	75	80	85
y_i	13.8	22.7	33.6	42.9	53.5	63.3	75.0	82.8	94.1	103.4

Apply linear least squares regression to find the values of a and b that produce the best-fit straight line.

Q. 4 (Q10.35)

The mean-time-to-failure (*MTTF*) of an integrated circuit is known to obey a law of the following form: $MTTF = C\exp T_0/T$, where T is the operating temperature and C and T_o are constants.
The following values of *MTTF* at various temperatures were obtained from accelerated-life tests.

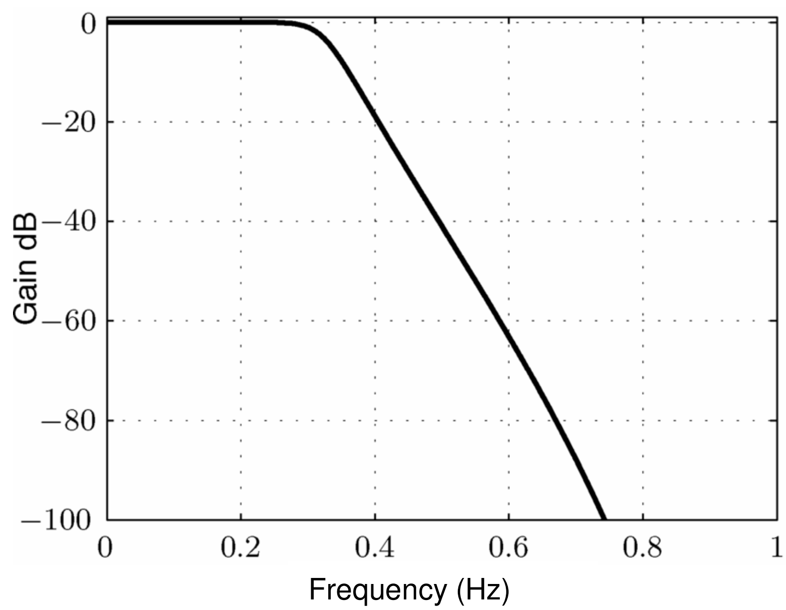
MTTF (h)	54	105	206	411	941	2145
Temperature (°K)	600	580	560	540	520	500

(a) Estimate the values of C and T_o. (Hint:$\log_e(MTTF) = \log_e(C) + T_0/T$. This equation is now a straight-line relationship between log(*MTTF*) and *1*/*T*, where log(*C*) and T_o are constants.)
(b) For a *MTTF*of 10 years, calculate the maximum allowable temperature.

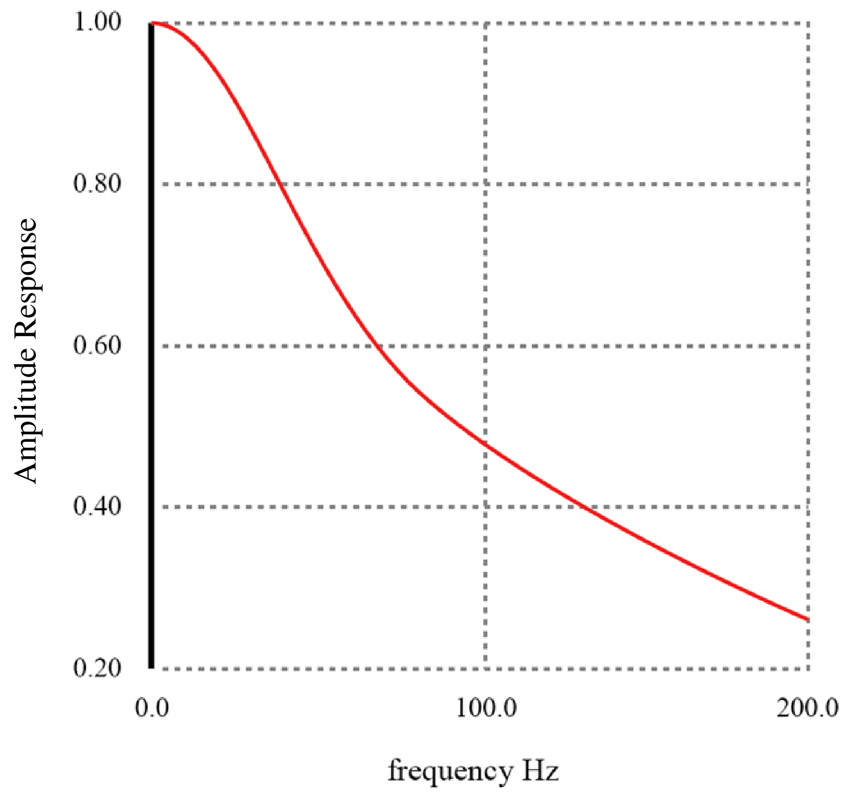
Q 5

Use 3-dB measure to appropriate estimate the cutoff frequency and the passband width (bandwidth) of the following two low pass filters, represented in dB (or log) and linear scales.

(a)



(b)

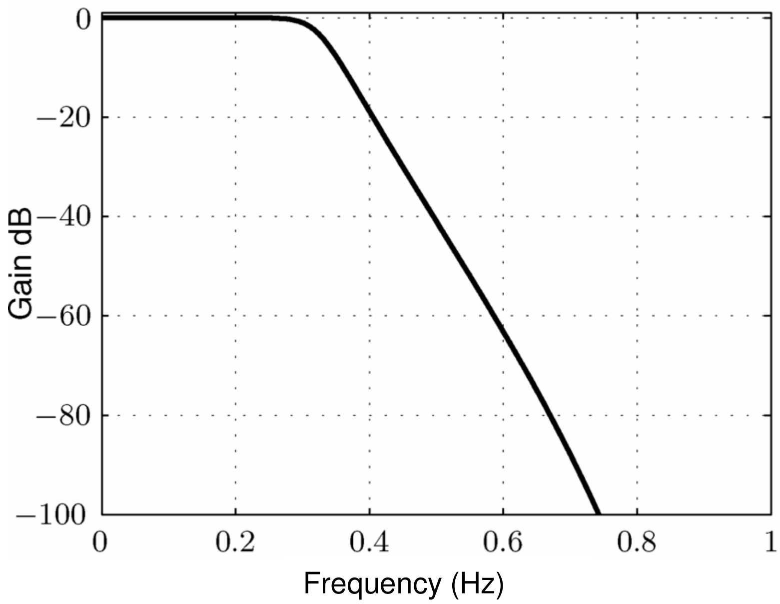


Amplitude Response
1.00
0.80
0.60
0.40
0.20
0.0
100.0
200.0
frequency Hz

Q. 5

Use 3-dB measure to appropriate estimate the cutoff frequency and the passband width (bandwidth) of the following two low pass filters, represented in dB (or log) and linear scales.

(a)



(b)