

University of Saskatchewan
Department of Electrical Engineering
EE 868.3 Digital Techniques for Power System Measurements (Term 1)
Final Examination (Classroom Examination)

Examination Paper Hand-In Time: 9:00 am, Dec.19, '07
Instructor: Dr. Rama Gokaraju

Return Time: 5:00pm
Total Marks: 50

Instructions:

- 1) **Important:** After the exam, return the question paper along with your answer booklets (including the unused ones).
- 2) This examination paper consists of 6 problems and 3 pages in total.
- 3) However, you are not permitted to discuss or take assistance of others to solve the examination problems. You would be severely penalized if your solutions point to the above.
- 4) Your solutions should be methodical. You would be penalized if your solutions are illegible.
- 5) Mark allotted for each problem is shown on the right margin.

Problem 1

Perform the arithmetic operations $(+52) + (-17)$ and $(-52) - (-17)$ in binary using signed-2's complement representation for negative numbers.

A fixed-point binary number system has 1 whole bit and 15 fractional bits. Represent decimal fraction 0.3 in the unsigned format. Represent decimal fraction -0.3 in the 2's-complement format.

0.010011001100110
1.101100110011010

Show the representation of the decimal number -6.25 in the ANSI/IEEE short and long floating-point format. If the number is not exactly representable, use the round operation.

1 10000001 1001000...

7.5 Marks

Problem 2

What is the transfer function for the RLC filter in Figure 1. Determine its poles and zeros.

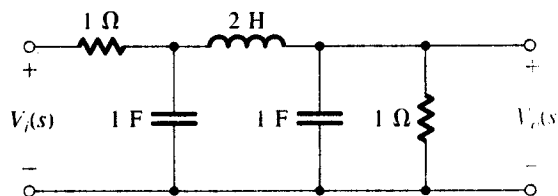


Figure 1

7.5 Marks

Problem 3

Draw the block diagram of a Dual-Ramp Converter and explain briefly its principle of operation.

5 Marks

Problem 4

Design a 8-bit successive approximation converter to convert 55.4 Volts into its digital value.

00110111

5 Marks

Problem 5

Suppose a current signal consists of two sine and cosine components and a noise component as follows:

$$z(t) = x_1 \cos \omega_0 t - x_2 \sin \omega_0 t + d(t)$$

where x_1 and x_2 are the independent variables and $d(t)$ is the measurement noise. The fundamental frequency is 60 Hz. The signal is sampled at 720 Hz.

The quantized values of its samples are listed below:

Sample No	Quantized Value	Sample No	Quantized Value	Sample No	Quantized Value
1	698	9	-270	17	-437
2	554	10	95	18	-656
3	264	11	435	19	-699
4	-100	12	656	20	-553
5	-431	13	700	21	-261
6	-657	14	559	22	94
7	-693	15	261	23	439
8	-551	16	-102	24	659

Use the Discrete Fourier Transform Technique to estimate the magnitudes of x_1 and x_2 . Show the steps of the technique clearly. Show the numerical steps clearly for one sample number.

10 Marks

$$x_1 = 700 \quad x_2 = 100$$

Problem 6

Suppose a current signal consists of two sine and cosine components, a decaying dc component and a noise component as follows:

$$z(t) = x_1 \cos \omega_0 t - x_2 \sin \omega_0 t + x_3 e^{-t/\tau} + d(t)$$

where x_1 , x_2 and x_3 are the independent variables and $d(t)$ is the measurement noise. The fundamental frequency is 60 Hz. The signal is sampled at 720 Hz.

The quantized values of its samples are listed below:

Sample No	Quantized Value	Sample No	Quantized Value	Sample No	Quantized Value
1	779	13	698	25	697
2	555	14	556	26	553
3	263	15	257	27	269
4	-101	16	-97	28	-94
5	-440	17	-440	29	-431
6	-652	18	-658	30	-660
7	-699	19	-696	31	-701
8	-552	20	-559	32	-557
9	-265	21	-265	33	-262
10	96	22	98	34	98
11	439	23	442	35	434
12	656	24	656	36	655

Design a least squares filter for estimating x_1 , x_2 and x_3 . Also estimate the time period of the decaying dc component. Use a 7 sample data window.

Show how the [A] matrix will look like. Show the numerical steps clearly for one sample number.

15 Marks



$$\begin{aligned}
 & x_1 \cos(\omega t + \theta_1) - x_2 \sin(\omega t + \theta_2) + x_3 e^{-t/\tau} \\
 & x_1 (\cos \omega t \cos \theta_1 - \sin \omega t \sin \theta_1) - x_2 (\sin \omega t \cos \theta_2 + \cos \omega t \sin \theta_2) \\
 & x_1 \cos \theta_1 \cos \omega t - x_1 \sin \theta_1 \sin \omega t - x_2 \sin \theta_2 \cos \omega t - x_2 \cos \theta_2 \sin \omega t + x_3 - x_3 \frac{t}{\tau} \\
 & y_3 = 0
 \end{aligned}$$