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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 **Return Time: 5:00pm**
Instructor: Dr. Rama Gokaraju **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.

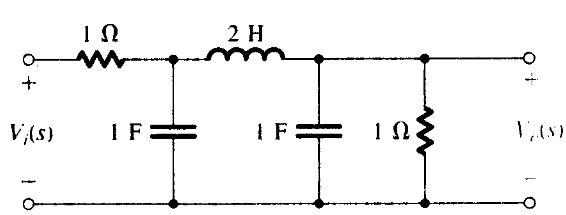

Figure 1

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

$X_1 = 700$ $X_2 = 100$

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

$x_1 \cos(\omega_0 t + \theta_1) - x_2 \sin(\omega_0 t + \theta_2) + x_3 e^{-t/\tau}$

$x_1 (\cos\omega_0 t \cos\theta_1 - \sin\omega_0 t \sin\theta_1) - x_2 (\sin\omega_0 t \cos\theta + \cos\omega_0 t \sin\theta)$

$x_1 \cos\theta_1 \cos\omega_0 t - x_1 \sin\omega_0 t \sin\theta_1 - x_2 \sin\omega_0 t \cos\theta_2 - x_2 \sin\theta_2 \cos\omega_0 t + x_3 - x_3 \frac{t}{\tau}$

$x_3 = 80$