Instructions Answer all questions. Give your answers clearly. Do not leave mathematical operations incomplete (do not skip intermediate operations and obtain the possible simplest form of the results). Calculator and cell phone are not allowed in the exam. Each question is worth 25 points. Time 60 minutes.


## QUESTIONS

Q1) a) Obtain the differential equation (input-output relation) characterizing the following system. The voltage, $y(t)$ is easily obtained from the circuit current.
b) Find the step response of the system by solving the differential equation in time domain.


Q2) Obtain type-II block diagram realization of the following LTI-causal system.

$$
y^{\prime \prime}(t)+5 y^{\prime}(t)+4 y(t)=x^{\prime \prime}(t)+4 x(t)
$$

Q3) State-form of a third order differential equation describing an LTI-casual system is given as in the following.
a) Plot the signal flow graph. The signal nodes in the graph are for $x(t), z_{3}^{\prime}(t), z_{3}(t), z_{2}(t)$ and $z_{1}(t)$.
b) Obtain the differential equation.

$$
\begin{aligned}
& {\left[\begin{array}{l}
z_{1}^{\prime}(t) \\
z_{2}^{\prime}(t) \\
z_{3}^{\prime}(t)
\end{array}\right]=\left[\begin{array}{rrr}
0 & 1 & 0 \\
0 & 0 & 1 \\
-4 & -8 & -5
\end{array}\right] \cdot\left[\begin{array}{l}
z_{1}(t) \\
z_{2}(t) \\
z_{3}(t)
\end{array}\right]+\left[\begin{array}{l}
0 \\
0 \\
1
\end{array}\right] \cdot x(t)} \\
& y(t)=\left[\begin{array}{lll}
1 & 0 & 0
\end{array}\right] \cdot\left[\begin{array}{l}
z_{1}(t) \\
z_{2}(t) \\
z_{3}(t)
\end{array}\right]
\end{aligned}
$$

Q4) Compute complex Fourier series coefficients of the following periodic signal.

$$
x(t)=-3+4 \cos (4 \pi t)-2 \sin \left(\frac{8 \pi}{3} t\right)+6 \cos \left(\frac{8 \pi}{3} t\right)+3 e^{j \frac{2 \pi}{3} t}
$$

