Question 1: (5 Marks)
Objective: This question deals with Separable Differential Equation.
Solve the initial value problem of the following Equation:
\[
\frac{dy}{dx} = -2yx, \quad y(0) = 2
\]

Question 2: (6 Marks)
Objective: This question deals with Exact Differential Equation.
Find the General solution of the following Equation:
\[
(2x^3 - xy^2 - 2y + 3)dx - (x^2y + 2x)dy = 0
\]

Question 3: (6 Marks)
Objective: This question deals with Bernoulli Equation.
Solve the following Equation:
\[
y'' = 5y + e^{-2x} y^{-2}
\]

Question 4: (6 Marks)
Objective: This question deals with Variation of Parameters Method.
Solve the Euler-Cauchy Non homogonous Differential Equation:
\[
x^2y'' - 2xy' + 2y = x^3
\]

Question 5: (4 Marks)
Objective: This question deals with Higher -Order Differential Equations.
Find the homogonous Differential Equation with constant coefficient that has the following particular solution:
\[
y = 7e^{3x} + 2x
\]

Question 6: (5 Marks)
Objective: This question deals with Undetermined Coefficients Method.
Solve the Non homogonous Differential Equation:
\[
y'' - y' = 4e^{-x} + 3e^{2x}
\]
**Question 7**  
(8 Marks)  
**Objective:** This question deals with Power Series Solution Method.  
Use the Legendre’s Equation to solve the following Differential Equation:

\[ y'' - 4xy' + (4x^2 - 2)y = 0 \]

**Question 8**  
(10 Marks)  
**Objective:** This question deals with Direct and Inverse Laplace Transform.  

a) Find the Laplace Transform of:

\[ f(t) = te^{-at} \sin t \]

b) Find the inverse Transform of

\[ F(s) = \frac{S^2}{(S-1)^4} \]

c) Find the inverse Transform of

\[ F(s) = \frac{16}{S(S^2 + 4)^2} \]

d) Use the Laplace Transform to find the particular solution:

\[ y'' + 6y' + 10y = \delta(t - \pi) \quad , \quad y(0) = 0 \quad , \quad y'(0) = 0 \]

**Good Luck**

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