2|5|'08 **EEL 824 NONLINEAR SYSTEMS**

MAJOR TEST Time: 2hrs., Marks: 40

Q.1:– Prove or disprove (!) the following identity –

$$L_{[f,g]}h(x) \overset{?}{=} L_f L_g h(x) - L_g L_f h(x) \qquad (4)$$

Q.2:– Let $f_1(x) = \begin{bmatrix} x_1 \\ 1 \\ 0 \\ x_3 \end{bmatrix}$, $f_2(x) = \begin{bmatrix} -e^{x_2} \\ 0 \\ 0 \\ 0 \end{bmatrix}$, $D = R^4$ (4)

If $\Delta = \text{Span}\{f_1, f_2\}$ then show whether Δ is INVOUTIVE or not.

Q.3:– Consider the system

$\dot{x}_1 = x_1 + x_2$, $\dot{x}_2 = 3x_1^2 x_2 + x_1 + u$ and $y = -x_1^3 + x_2$

(a) Is the system input-output linearizable? Answer with reasons.

(b) If yes, then transform it into normal form and specify the region over which the transformation is valid.

(d) Is the system feedback linearizable? Give reasons.

(e) If yes, then find a feedback control law and a change of variables that linearize the state equations.

~~Q.4:~~ (C) Find the zero dynamics motion and show whether system is minimum phase or not. (20)

Q.4:– Let $\dot{x}_1 = x_2$, $\dot{x}_2 = -x_1 + x_2(2 - 3x_1^2 - 2x_2^2)$.

Is it possible to use Poincare-Bendixson's criterion to show that this system has a periodic orbit. (6)

Q.5:– Let $\dot{x}_1 = x_2$, $\dot{x}_2 = -x_1 + \varepsilon(1 - x_1^2)x_2$

where ε is a parameter with nominal value $\varepsilon_0 = 1$.

If $x(t, \varepsilon_0)$ is the solution of system for nominal parameter value, find the solution (approximate) when parameter deviates to $\varepsilon = \varepsilon_0 + \delta$ where δ is small deviation.

(6)