Please show with steps how you arrive at the final answer

(a) Let $z = 3x^2 - 2xy + x^2 y = 2$.

(i) find the vector which is normal to the curve at (1,1) (3 marks)

(ii) write down a unit vector $\underline{d}$ along the line y=x and directed at the positive x direction. (2 marks)

(ii) Find the rate of change of z in the direction of $\underline{d}$. (2 marks)

(b) The electric intensity of a electrostatic function V(x,y,z) is E= -∇V

The electrostatic potential produced by a unit dipole-moment, located at the origin and directed along the y-axis , is given by

$$V(x, y, z) = \frac{y}{(x^2 + y^2 + z^2)^{3/2}} \quad (x,y,z) \neq (0,0,0)$$

(i) Determine the corresponding field-intensity function E. (6 marks)

(ii) In what direction, does the potential decreases most rapidly from the point (4,2,4)? (2 marks)

(c) (i) If $\underline{F} = y^2 \underline{i} - 3x^2 \underline{j} + yz\underline{k}$, find $\nabla \times \underline{F}$ and $\nabla \bullet \underline{F}$ (3 marks)

(ii) Show that $\underline{G} = 2xy^3 \underline{i} + (1 + 3x^2 y^2)\underline{j}$ is conservative vector field on the entire plane. (3 marks)

(iii) Find a potential function Φ so that ∇Φ=G. (3 marks)