Mid Point Ellipse Algorithm:

$$\frac{x^2}{a^2} + \frac{y^2}{b^2} = 1 \quad \text{[Ellipse Equation]}$$

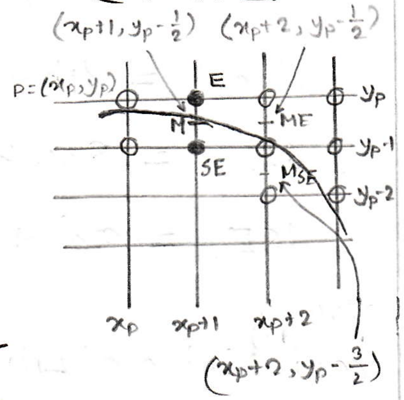
$$\Rightarrow \frac{b^2x^2 + a^2y^2}{a^2b^2} = 1$$

$$\Rightarrow b^2x^2 + a^2y^2 - a^2b^2 = 0$$

Region-1:

$$F(x,y) = b^2x^2 + a^2y^2 - a^2b^2$$

$$F(P) = b^2x_p^2 + a^2y_p^2 - a^2b^2 \qquad [F(P) = F(x_p, y_p)]$$



$$F(M) = F(x_p+1, y_p - \frac{1}{2})$$

$$= b^2(x_p+1)^2 + a^2(y_p - \frac{1}{2})^2 - a^2b^2$$

$$F(M_E) = F(x_p+2, y_p - \frac{1}{2})$$

$$= b^2(x_p+2)^2 + a^2(y_p - \frac{1}{2})^2 - a^2b^2$$

$$F(M_{SE}) = F(x_p+2, y_p - \frac{3}{2})$$

$$= b^2(x_p+2)^2 + a^2(y_p - \frac{3}{2})^2 - a^2b^2$$

$$\therefore d_{init} = F(M) - F(P)$$

$$= b^2(x_p+1)^2 + a^2(y_p-\frac{1}{2})^2 - a^2b^2 - b^2x_p^2 - a^2y_p^2 + a^2b^2$$

$$= b^2(x_p^2 + 2x_p + 1) + a^2(y_p^2 - y_p + \frac{1}{4}) - b^2x_p^2 - a^2y_p^2$$

$$= b^2x_p^2 + 2b^2x_p + b^2 + a^2y_p^2 - a^2y_p + \frac{a^2}{4} - b^2x_p^2 - a^2y_p^2$$

$$= b^2 + 2b^2x_p + \frac{a^2}{4} - a^2y_p$$

$$\therefore d_E = F(M_E) - F(M)$$

$$= b^2(x_p+2)^2 + a^2(y_p-\frac{1}{2})^2 - a^2b^2 - b^2(x_p+1)^2 - a^2(y_p-\frac{1}{2})^2 + a^2b^2$$

$$= b^2x_p^2 + 4x_pb^2 + 4b^2 - b^2x_p^2 - b^2 2x_p - b^2$$

$$= 2x_pb^2 + 3b^2$$