Exiton-Drift diffusion equations (complete form): 3 Equations of drfit diffusion equation are as following:

The first equation is:

$$\nabla.(\lambda^2\varphi) - n + p = 0 \tag{1}$$

One can find derivative of equation 1 respects to n, p and φ in equation 2. This is an important step for finding Jacobian.

$$Der \Rightarrow \nabla.(\lambda^2\delta\varphi) - \delta n + \delta p = 0 \tag{2}$$

The weak form of equation 2 is shown in equation 3:

$$Weakfom \Rightarrow -(\nabla\omega, \lambda^2\delta\varphi) - (\omega, \delta n) + (\omega, \delta p) = 0 \tag{3}$$

By using Galerkin method, we can find the first row of Jacobian matrix as following:

$$\underbrace{-(dN(i,k), \lambda^2 dN(j,k))}_{A[11]} - \underbrace{(N(i), N(j))}_{A[12]} + \underbrace{(N(i), N(j))}_{A[13]} \tag{4}$$

Residual of the equation 1 can be written as:

$$\underbrace{(dN(i,k), \lambda^2 d\varphi_{,k}) - (N(i), n_{pre}) - (N(i), p_{pre})}_{b[1]} \tag{5}$$

The second equation of Drift Diffusion problem is:

$$\nabla.(J_n) - U = 0 \tag{6}$$

Which $J_n = -\mu_n n\nabla\varphi + \mu_n\nabla n$, So equation 5 will be in form of:

$$\nabla.(-\mu_n n\nabla\varphi + \mu_n\nabla n) - U \tag{7}$$

By considering that $U = -K_{diss}X + \gamma np$, derivative of equation 6 will be in form of:

$$Der \Rightarrow \nabla.(-\mu_n\delta n\nabla\varphi - \mu_n n\nabla\delta\varphi + \mu_n\nabla\delta n) - \gamma\delta np - \gamma n\delta p \tag{8}$$

and the weak form is:

$$(\nabla\omega, \mu_n n\nabla\delta\varphi) + (\nabla\omega, \mu_n\nabla\varphi\delta n - \mu_n\nabla\delta n)) + (\omega, -\gamma\delta np) + (\omega, -\gamma n\delta p) \tag{9}$$

Equation 8 shows the second row of Jacobian matrix:

$$\underbrace{(dN(i,k), \mu_n n dN(j,k))}_{A[21]} +$$

$$\underbrace{(dN(i,k), \mu_n\varphi_{,k}N(j) - \mu_n dN(j,k)) + (N(i), -\gamma p N(j))}_{A[22]}$$

$$\underbrace{(N(i), -\gamma n N(j))}_{A[23]} \tag{10}$$

Residual of the equation 6 can be written as:

$$\underbrace{-(dN(i,k), -\mu_n n^{pre} d\varphi_{,k} + \mu_n dn^{pre}_{,k}) + (N(i), K_{diss} X^{pre}) - (N(i), \gamma n^{pre} p^{pre})}_{b[2]} \tag{11}$$

Third equation is similar to the second equation and $J_p = -\mu_p p \nabla\varphi - \mu_p \nabla p$, So by doing the same procedure the weak form will be in form of:

$$Weakform \Rightarrow -(\nabla\omega, \mu_p p \nabla\delta\varphi) - (\nabla\omega, \mu_p \nabla\varphi\delta p + \mu_p \nabla\delta p)) + (\omega, -\gamma\delta n p) + (\omega, -\gamma n \delta p) \tag{12}$$

Equation 11 represents the third row of Jacobian matrix:

$$\underbrace{(dN(i,k), \mu_p p dN(j,k))}_{A[31]} +$$

$$\underbrace{(N(i), \gamma p N(j))}_{A[32]} +$$

$$\underbrace{(dN(i,k), \mu_p \varphi_{,k} N(j) + \mu_p dN(j,k)) - (N(i), n\gamma N(j))}_{A[33]} \tag{13}$$

Residual of the third equation can be written as:

$$\underbrace{(dN(i,k), \mu_p p^{pre} d\varphi_{,k} + \mu_p dp^{pre}_{,k}) - (N(i), K_{diss} X^{pre}) + (N(i), \gamma n^{pre} p^{pre})}_{b[3]} \tag{14}$$

The last equation of drift diffusion equations can be written as:

$$-\nabla.(\mu_x \nabla X) = G - K_{diss} X - \tau X + \gamma n p = 0 \tag{15}$$

The Equation LHS of Exciton (in DDExciton) with assumption of constant G will be as following:

$$\underbrace{(\tau + K_{diss})(dN(i,k), dN(j,k)) + \mu_x (N(i), N(j))}_{Ae} \tag{16}$$

The RHS for Exciton equation is:

$$\underbrace{(G + \gamma n p) N(i)}_{be} \tag{17}$$