## Advantages of a Variational principle formulation

(1) It is possible to extend this to non-mechanical systems.

(2) For eg. consider a Lagrangian $L$ for a system:

$$L = \frac{1}{2}\sum_j L_j \dot{q}_j^2 + \frac{1}{2}\sum_{\substack{j,k \\ j\neq k}} M_{jk}\dot{q}_j\dot{q}_k - \sum_j \frac{q_j^2}{2C_j} + \sum_j E_j(t)\, q_j$$

with a dissipation fn.

$$F_D = \frac{1}{2}\sum_j R_j \dot{q}_j^2$$

(3) The resulting Lagrange's eqns. are: (For a particular $j$)

$$L_j \frac{d^2 q_j}{dt^2} + \sum_{\substack{k \\ j\neq k}} M_{jk}\frac{d^2 q_k}{dt^2} + R_j \frac{dq_j}{dt} + \frac{q_j}{C_j} = E_j(t) \quad (1)$$

If this is an electrical system, it describes a system of coupled circuits with:

$L_j$'s $\rightarrow$ self inductances

$M_{jk}$'s $\rightarrow$ mutual inductances

$R_j$'s $\rightarrow$ resistances

$C_j$'s $\rightarrow$ Capacitances

$q_j$'s $\rightarrow$ charges $\rightarrow$ $\dot{q}_j$ $\rightarrow$ currents

& $E_j$'s $\rightarrow$ external e.m.f.s.

(1) Alternatively it can describe a set of coupled springs ~~obe~~ obeying Hooke's law with $L_j$'s & $M_{jk}$ being masses (inertial terms)

$\frac{1}{C_j\text{'s}} \rightarrow$ the spring constants $k$

$q_k \rightarrow$ displacement

& $E_j$'s $\rightarrow$ time varying forces

The dissipative forces originate from friction.

How $H$ can be conserved & yet not be the total energy & vice-versa.

(1) The precise way to obtain ~~a~~ $L$, the lagrangian is: $L = T - V$

(2) Thus a change of the generalized co-ordinates may change the functional appearance of $L$ but not it's magnitude.

(3) However, $\because$ $H$ depends in both magnitude & functional form on the co-ordinates, a change of co-ordinates can lead to a completely different Hamiltonian