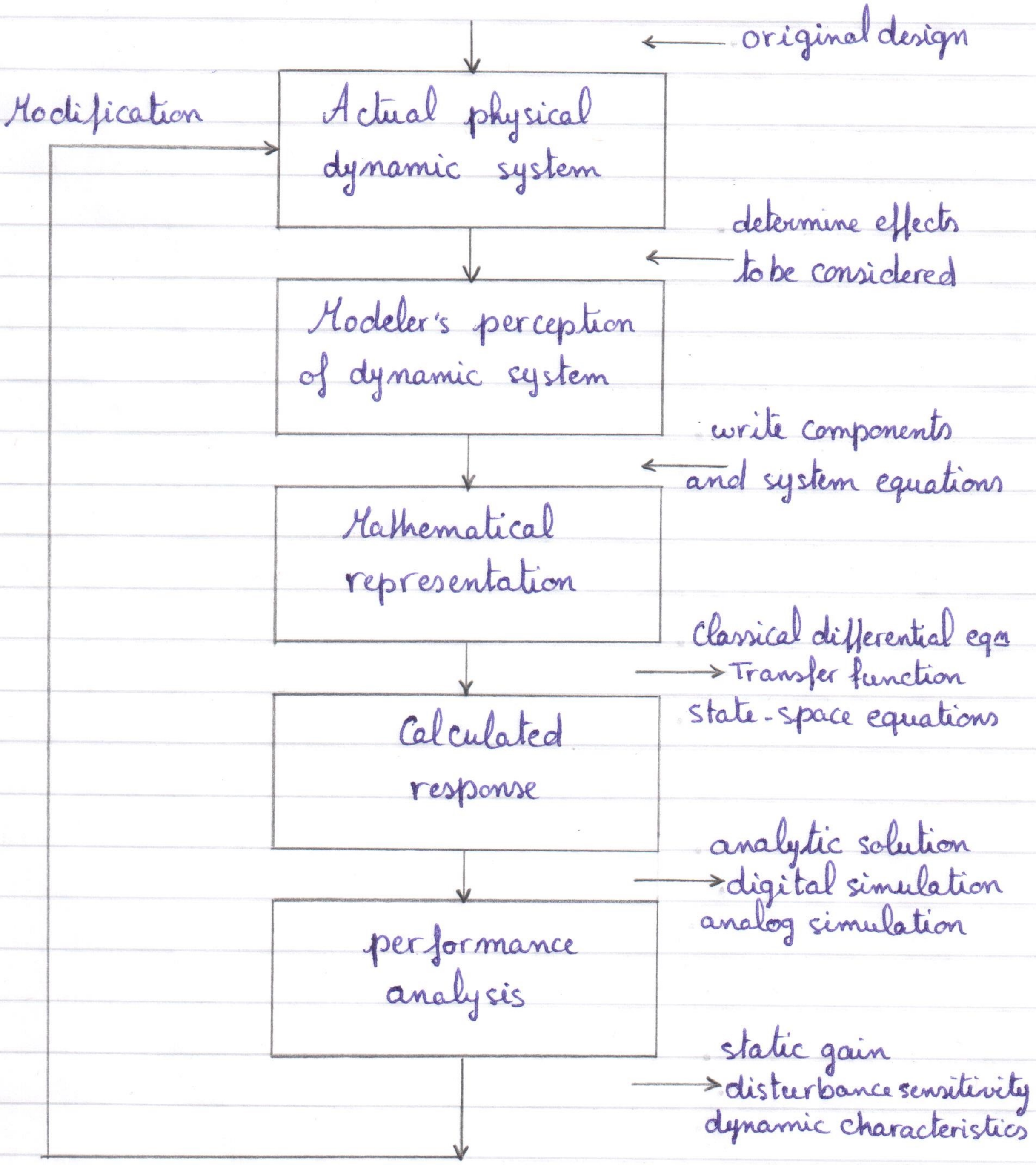
→ steps in modeling

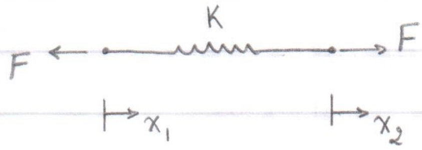
"modeling sequence and levels of representation"



→ define . with neat sketch.

* translational systems.

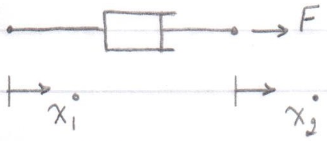
1. spring



$$F = K(x_2 - x_1)$$ → for a linear spring

K → spring constant (N/m)

2. dampers (dashpot)

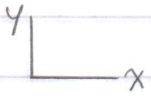


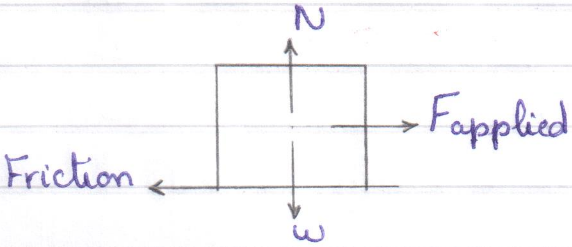
$$F = b(\dot{x}_2 - \dot{x}_1)$$ → for a linear damper

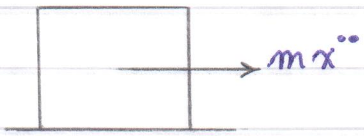
b → damping constant (N.S/m)

* in viscous damper, the generated force is due to pressure drop across a fluid resistor.

3. discrete mass







$$F = m\ddot{x}$$

* Coulomb friction represents the sliding friction between two surfaces.
  This friction depends on the coefficient of friction and the normal force that posses the two surfaces together

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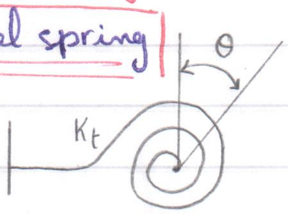
* **Rotational systems.**

1. rotational spring



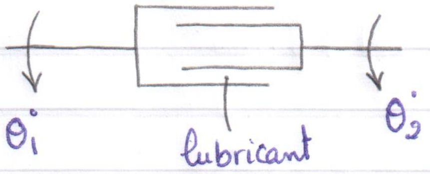
" Clock spring "
" fixed end shafts "

for linear torsional spring

$$T = K_t \, \theta$$

- T → torque (N.m)
- K_t → torsional spring constant (N.m)
- θ → deflection angle of twist (rad.)

2. rotational damper

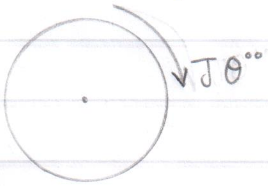


$$T = b(\dot{\theta}_2 - \dot{\theta}_1)$$

b → torsional damping coefficient (N.m.s)

3. Discrete inertia

it is the resistance of an object to angular acceleration
it depends on the mass and the geometry of the object



$$\sum M_x = J_x \ddot{\theta}_x$$ → Newton's 2nd law

- $\sum M_x$ → sum of moments
- J_x → discrete inertia $(N.m.s^2) = kg\,m^2$
- $\ddot{\theta}_x$ → angular accel. (rad/s^2)

① For Fluid systems, define: Capacitance, inductance and resistance.

Answer:

* **Fluid Capacitance:-** it relates how fluid energy can be stored by virtue of pressure.

$$Q = \frac{V}{B} \dot{P}_{cv}$$

$$\therefore C_f = \frac{V}{B}$$

$$\boxed{i = C\frac{de}{dt}}$$

* **Fluid Inductance:-** is often called fluid "inertance" since its effects is due to the inertia of a moving in compound fluid in a fluid line of constant area

$$L = \frac{\rho L}{A} \qquad \text{as} \quad \delta p = \frac{\rho L}{A}\dot{Q}$$

$$\boxed{e = L\frac{di}{dt}}$$

* **Resistance:-** A fluid resistor dissipates power and can have a large variety of forms:
  - → laminar flow resistance
  - → orific type or head loss ress.
  - → Compressible flow resistance.

$$\boxed{e = iR}$$

② Discuss The Reynolds number effects?

Answer

$$N_r = \frac{\text{inertial flow forces}}{\text{viscous flow forces}} = \frac{\propto \rho A V^2}{\propto \mu d V} = \frac{\rho d^2 V^2}{\mu d V}$$

$$= \frac{\rho V d}{\mu} = \frac{V d}{\nu}$$

→ Small N_r ↓ ← viscous flow forces ↑↑

→ N_r ↑ ← effects of the inertial forces ↑↑↑ to break the streamlined flow.

→ in laminar flow, The Pressure loss due to The friction like electrical resis. ($V \propto I$)

→ in turbulent flow, Pressure loss $\propto$ Flow^2

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③ Speed of Sound differ between liquid and gases. Discuss.

Answer

→ speed of Sound $C_o = \sqrt{\frac{B}{\rho}}$ ← B: bulk modulus, ← ρ: density

→ at high speeds $B = KP$ case $K = \frac{C_P}{C_V}$ ← specific heat ratio

→ ∴ $C_o = \sqrt{KRT}$ $C_o = \sqrt{\frac{B}{\rho}} = \sqrt{\frac{KP}{\rho}} = \sqrt{KRT}$

→ specific heat of a fluid is The amount of heat required to raise the temp of a unit of mass of fluid by 1 degree.

k (for liquid) $\simeq 1.04$ / k(air) $= 1.4$

إجابة السؤال ده الـ Page كاملة

④ Compare between Viscosity of liquids and gases.

Answers:-

* liquids: $\mu \downarrow$ as Temp. $\uparrow$

$$\mu = \mu_o e^{-\lambda_L (T-T_o)}$$

where: μ_o, T_o Values at reference Conditions
λ_L Constant depends on the liquid

* Gas: $\mu \uparrow$ as Temp $\uparrow$

$$\mu = \mu_o + \lambda_G (T - T_o)$$

↳ Const. depends on the Gas

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⑤ Compare between Newtonian fluid and Non-Newtonian?

Answers:-

* Newtonian fluid:- a fluid in which the absolute viscosity is independent of the shear rate

* Non-Newtonian fluid:- has a variable viscosity, depending upon the shear rate.

* Kinematic Viscosity:- $\nu = \frac{\mu}{\rho}$

① Declare with neat sketches, basic effects of Thermal system.

Answer:- ① **Thermal Conduction:** it is the ability of solid or continuous media to conduct heat.

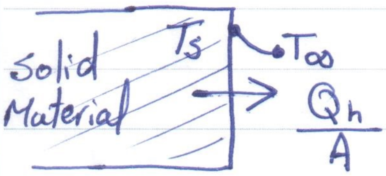
$$\frac{Q_h}{A} = -k_t \frac{dT}{dx}$$ } Fourier's law

heat transfer → Q_h

k_t → heat Conductivity

$\frac{dT}{dx}$ → Temp. gradient in the direction of heat flow

② **Thermal Convection:** it's the process of heat transfer between a surface of a solid material and a fluid that is exposed to solid surface.

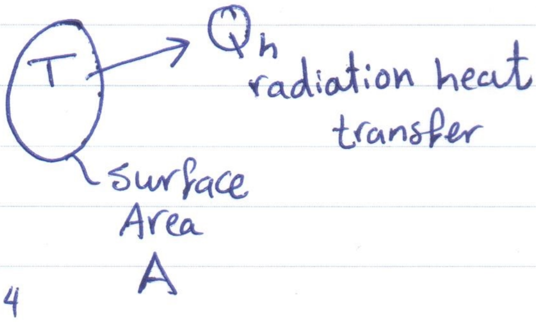


$$\boxed{\frac{Q_h}{A} = h\,(T_s - T_\infty)}$$ Newton's law

h: Convection coefficient

③ **Thermal Radiation:** it's the process of heat transfer in which the energy is high enough to transfer heat without the presence of a surrounding medium as fluid or solid

$$\boxed{\frac{Q_h}{A} = \sigma T^4}$$



where, $\sigma = 56.68 * 10^{-9}$ watt/$m^2 k^4$

Boltzmann Constant

(4) Thermal Capacitance: it's The behavior of The material when it holds or store heat

$$Q_h = \underbrace{C_p m}_{\text{heat Capacity}} \frac{dT}{dt}$$

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[2] Discuss in brief The Dynamic Thermal system
- Then state Biot Number showing The effects of diff. lengThs
- Then show The Cases of Biot Number

Answer

- heat Capacity is ↑↑ to be a rate of Change of temp. with time.

Biot Number: $N_b = \frac{R_{cond}}{R_{conv}} = \frac{h L_C}{K}$

L_C: Chr. lengTh of material

$$L_C = \frac{V}{A} = \text{Thickness for plate}$$

$$= \frac{\text{Thick}}{2} \quad \text{for fin}$$

$$= \frac{\text{diameter}}{4} \quad \text{for long Cylinder}$$

$$= \frac{\text{diameter}}{6} \quad \text{for sphere}$$

* if N_b is small ($N_b < 0.1$)

$\therefore R_{cond} < R_{conv}$.

we can consider
- → single lump of capacitance
- → heat capacity of solid material
- → heat transfer due to convection

Thermal conduction resistance isn't considered

* if N_b is large ($N_b > 0.1$)

$\therefore R_{cond} > R_{conv}$

There is temp. diff. inside the solid material.