



IIT ROORKEE



NPTEL ONLINE
CERTIFICATION COURSE

MATHEMATICAL MODELLING

ROTATIONAL MECHANICAL SYSTEM

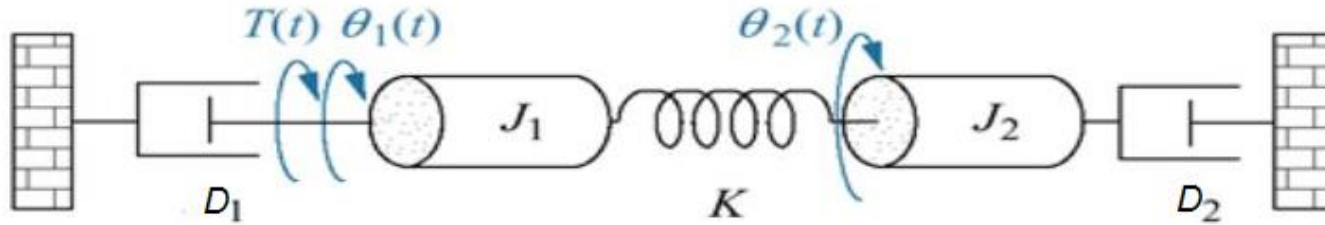
DR ANIL KUMAR

DEPARTMENT OF MECHANICAL AND INDUSTRIAL ENGINEERING

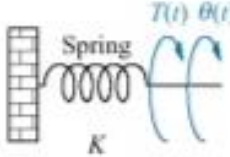
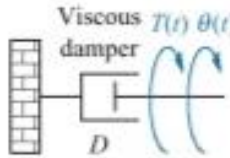
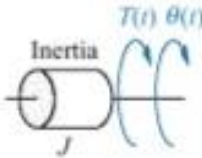


ROTATIONAL SYSTEMS

- Rotational mechanical systems are handled the same way as translational systems, except that torque replaces force and angular displacement replaces translational displacement
- Let's find the transfer function $\theta_2(s)/T(s)$

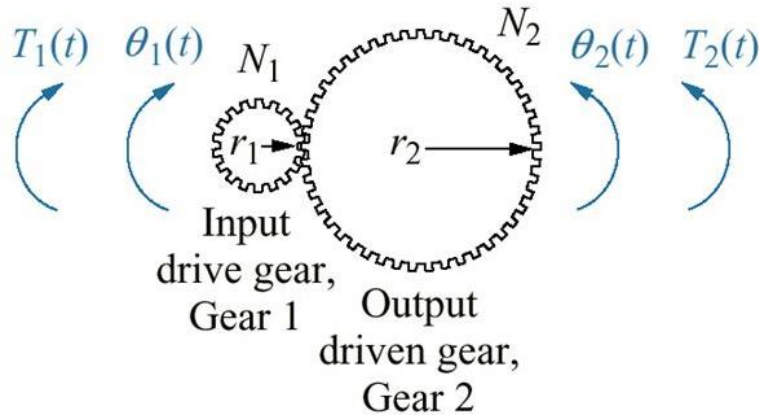


ROTATIONAL SYSTEMS : IMPEDANCES

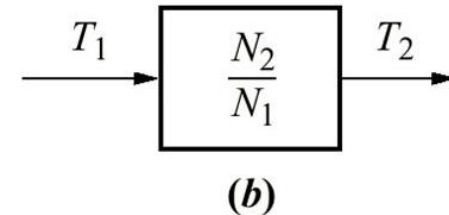
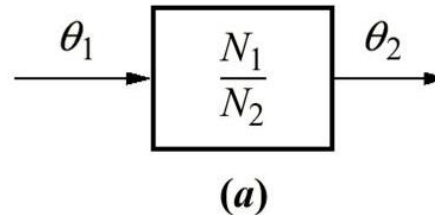
Component	Torque-angular velocity	Torque-angular displacement	Impedance $Z_M(s) = T(s)/\theta(s)$
	$T(t) = K \int_0^t \omega(\tau) d\tau$	$T(t) = K\theta(t)$	K
	$T(t) = D\omega(t)$	$T(t) = D \frac{d\theta(t)}{dt}$	Ds
	$T(t) = J \frac{d\omega(t)}{dt}$	$T(t) = J \frac{d^2\theta(t)}{dt^2}$	Js^2

SYSTEMS WITH GEARS

- Gears provide mechanical advantage to rotational systems and hence, gears are present in many applications



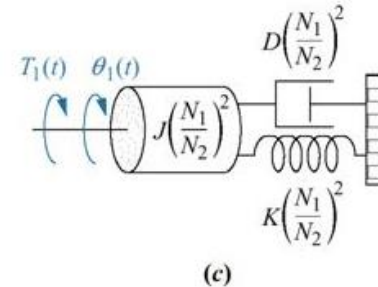
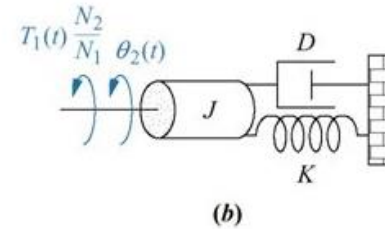
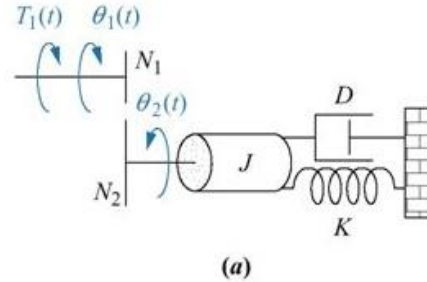
Transfer functions for **a.** angular displacement in lossless gears and **b.** torque in lossless gears



SYSTEMS WITH GEARS

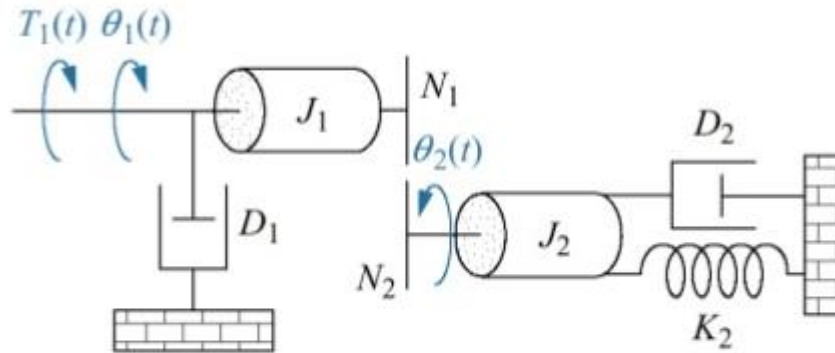
- Rotational mechanical impedances can be reflected through gear trains by multiplying the mechanical impedance by the ratio

$$\left(\frac{\text{Number of teeth of gear on } \textit{destination shaft}}{\text{Number of teeth of gear on } \textit{source shaft}} \right)^2$$



- a.** Rotational system driven by gears;
- b.** equivalent system at the output after reflection of input torque;
- c.** equivalent system at the input after reflection of impedances

SYSTEMS WITH GEARS



Find Transfer Function? $\frac{\theta_2(s)}{T_1(s)}$

REFERENCE BOOKS

- Norman S. Nise, Control Systems Engineering, Wiley, 2013
- Katsuhiko Ogata, Modern Control Engineering, Prentice Hall, 2010.

