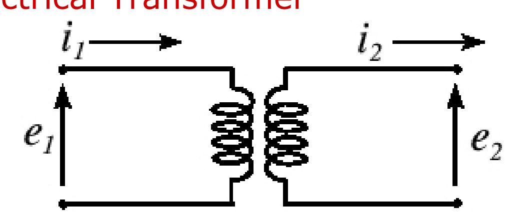
ME242 – MECHANICAL ENGINEERING SYSTEMS

LECTURE 29:

- Systems with Ideal Machines 4.2

ELECTRICAL CIRCUITS

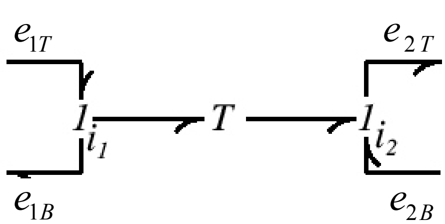
Electrical Transformer



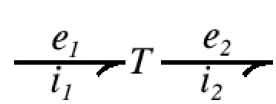
$$e_1 = Te_2$$
$$i_2 = Ti_1$$

$$e_1 = e_{1T} - e_{1B}$$
$$e_2 = e_{2T} - e_{2B}$$

usually : $e_{1B} = e_{2B} = 0$



or



ELECTRICAL CIRCUITS - TRANFORMER

SYSTEM

modulus equals ratio of coil turns

does not transmit DC

poor performance at high frequencies

MODEL

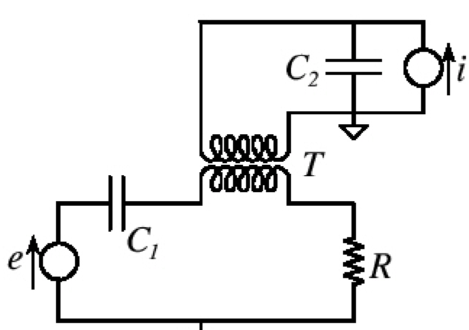
modulus equals ratio of coil turns

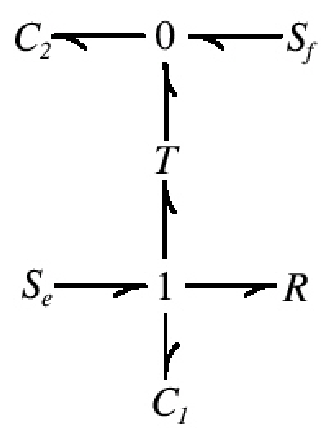
does transmit DC

good performance at high frequencies

ELECTRICAL CIRCUITS

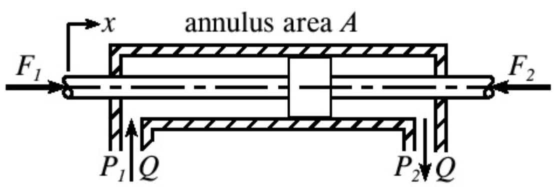
Example:

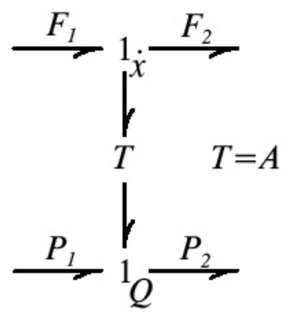




FLUID/MECHANICAL SYSTEMS

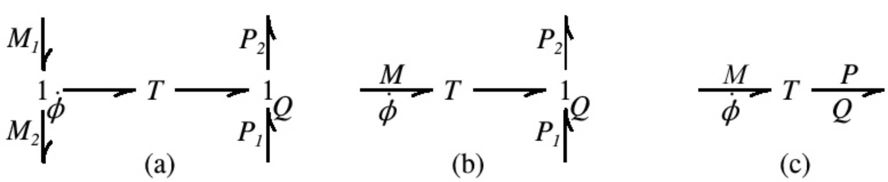
Positive Displacement Machine: Double-Rod-End Cylinder





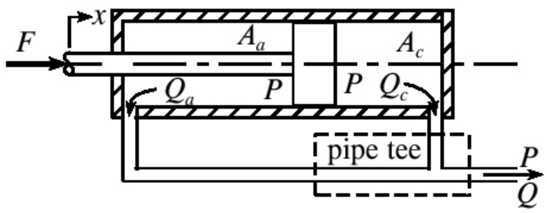
FLUID/MECHANICAL SYSTEMS

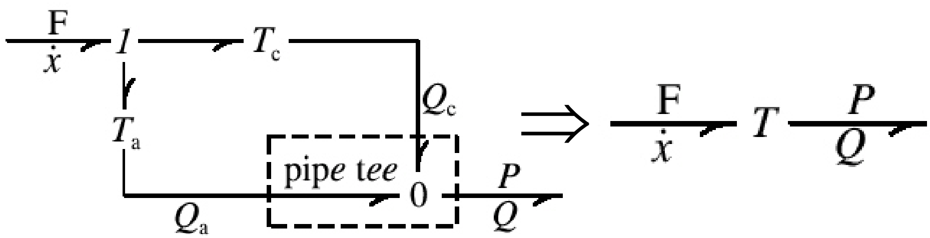
Positive Displacement Machine: Rotary Hydraulic Pump



FLUID/MECHANICAL CIRCUITS

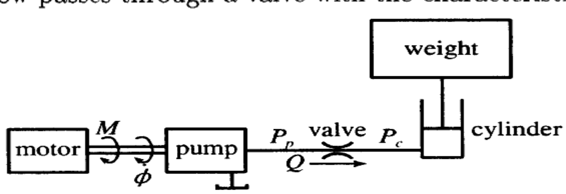
Example:

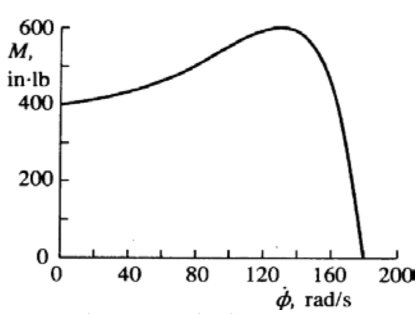


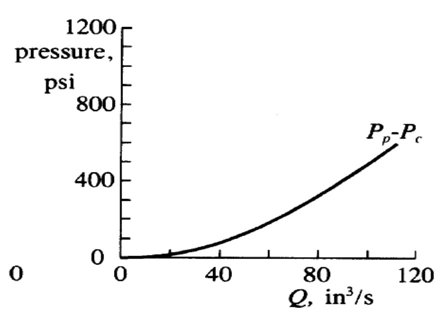


FLUID/MECHANICAL CIRCUITS

4.10 A motor drives a pump to supply a hydraulic cylinder that lifts a 3000-lb weight. The torque-speed characteristic of the motor is plotted on the next page. The displacement of the pump is 0.50 in^3/rad, and the area of the cylinder is 5.0 in^2. The flow passes through a valve with the characteristic also plotted.







FLUID/MECHANICAL CIRCUITS

(a) Model the system with a bond graph, neglecting inertia, friction and leakage.

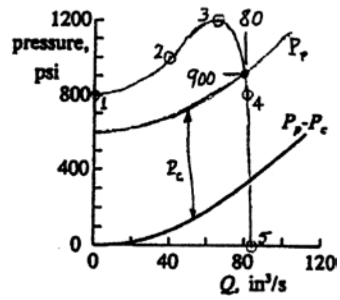
$$S \xrightarrow[\dot{\phi}]{M} T_p \xrightarrow{P_p} 1_{Q} \xrightarrow{P_c} T_c \xrightarrow[\dot{y}]{W=3000\,lb} S_e$$

$$1 \rightharpoonup R$$

$$T_p = \frac{Q}{\dot{\phi}} = 0.50\,\frac{in^3}{rad} \qquad T_c = \frac{\dot{y}}{Q} = \frac{1}{5} = 0.2\ in^{-2}$$

(b) Determine the pressure P_c in the cylinder, and add it to the plotted pressure $P_p - P_c$ to get an effective load characteristic as seen by the pump.

$$P_c = \frac{W}{T_c} = 600\,\frac{lb}{in^2}$$

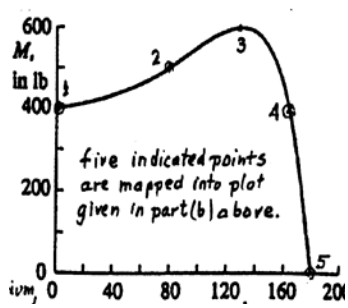


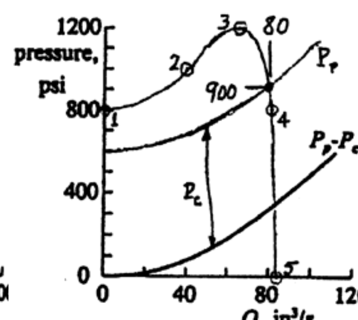
FLUID/MECHANICAL CIRCUITS

(c) Transform the given torque-speed motor characteristic to plot an equivalent pressure-flow source characteristic at the outlet of the pump on the same axes as the plot of part (b).

$$P_p = \frac{1}{T_p} M = 2M$$

$$Q = T_p \dot{\phi} = 0.5\dot{\phi}$$





(d) Determine the equilibrium pressure P_p and flow Q, the speed at which the weight rises and the torque and angular velocity of the motor.

At equilibrium, $P_p = 900$ psi ; $Q = 80\,in^3/s$

$\dot{y} = T_c Q = 16\,in/s$; $M = T_p P_p = 450$ in lb; $\dot{\phi} = \frac{Q}{T_p} = 160\,\frac{rad}{s}$