Thermodynamics
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Lecture - 21
Tutorial problem – Part 1

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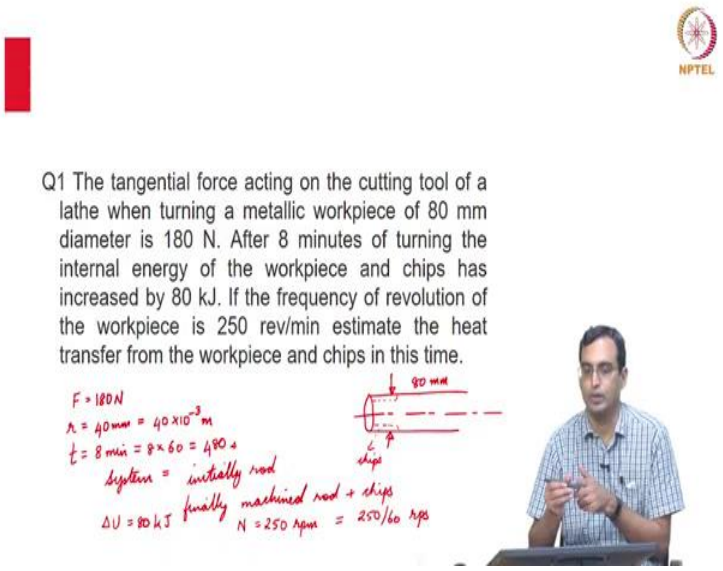

Figure 1.

Solution of the problem in Fig. 1:

F = 180 N, r = 40 mm = 0.04 m, t = 8 min = 480 s, N = 250 rpm = 250/60 rps

Initially, the system is only the metallic workpiece. Finally the system is the machined workpiece and the chips.

Torque is acting on the workpiece.

Cutting torque, $T = Fr = 180 \times 0.04 = 7.2\ Nm$

Work done, $W = T\theta = T(2\pi Nt) = 7.2 \times \left(2\pi \times \frac{250}{60} \times 480\right) = 90.4\ kJ$

Here, work is done on the system. Hence, W = -90.4 kJ

Now, $\Delta U = 80\ kJ$

According to the first law for a process, $\delta Q - \delta W = dU$ (ignoring changes in potential and kinetic energy).

Integrating, $Q - W = \Delta U \rightarrow Q - (-90.4) = 80 \rightarrow Q = -10.4\ kJ$

Heat transfer is negative. The workpiece gets heated during the turning operation and its temperature increases. Hence, it loses heat to the surroundings.

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