



Information

AI Chat

MECH ENG 3R03 Formula Sheet

formula sheet

Course

Mechanical Engineering Design II (Mech Eng 3E05)

23 documents

University

McMaster University

Academic year: 2020/2021

Uploaded by:

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University of Waterloo

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AO4

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AI Quiz

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Change in internal energy

$$Q = mc_p \Delta T$$

$$q = m'c_p \Delta T$$

$$m' = \frac{q}{H}$$

Steady-Heat Transfer without Heat Sources, without Radiation

Plates,

$$q = \frac{A \Delta T}{\frac{1}{h_i} + \sum_{i=1}^n \frac{L_i}{k_i} + \frac{1}{h_o}}$$

Cylinders,

$$q = \frac{2\pi L \Delta T}{\frac{1}{h_i r_i} + \sum_{i=1}^n \frac{\ln(r_{i+1}/r_i)}{k_i} + \frac{1}{h_o r_0}}$$

Spheres,

$$q = \frac{4\pi \Delta T}{\frac{1}{h_i r_i^2} + \sum_{i=1}^n \frac{1}{r_i} \frac{1}{r_{i+1}} + \frac{1}{h_o r_0^2}}$$

Radiation

$$q = \varepsilon \sigma A (T_1^4 - T_2^4)$$

$$\sigma = 5.67 \times 10^{-8} \frac{W}{m^2 \cdot K}$$

$$\varepsilon = \text{Surface Emissivity}, 0 < \varepsilon < 1$$

Heat Transfer with Heat Sources

Plates,

$$q = \frac{A \Delta T}{\frac{1}{h_i} + \sum_{i=1}^n \frac{L_i}{k_i} + \frac{1}{h_o}}$$

$$\frac{T_b - T_\infty}{T_b - T_\infty} = \frac{\cosh(mL)}{\cosh(mL)}$$

$$q = \sqrt{hpkA_c} \Delta T \tanh(mL)$$

Specified fin tip temperature,

$$\frac{T(x) - T_\infty}{T_b - T_\infty} = \frac{\left[\frac{T_L - T_\infty}{T_b - T_\infty} \right] \sinh(mx) + \sinh(m(L-x))}{\sinh(mL)}$$

$$q = \sqrt{hpkA_c} \Delta T \frac{\cosh(mL) - \left[\frac{T_L - T_\infty}{T_b - T_\infty} \right]}{\sinh(mL)}$$

Convection from Fin Tip,

$$\frac{T(x) - T_\infty}{T_b - T_\infty} = \frac{\cosh(m(L-x)) + \left(\frac{h}{mk} \right) \sinh(m(L-x))}{\cosh(mL) + \left(\frac{h}{mk} \right) \sinh(mL)}$$

$$q = \sqrt{hpkA_c} \Delta T \frac{\sinh(mL) + \left(\frac{h}{mk} \right) \cosh(mL)}{\cosh(mL) + \left(\frac{h}{mk} \right) \sinh(mL)}$$

Fin Efficiency,

$$\eta_{fin} = \frac{q_{fin}}{q_{fin,max}}$$

$$\eta_{longfin} = \frac{1}{\tanh(mL)}$$

$$\eta_{adiabatictip} = \frac{\tanh(mL)}{mL}$$

$$\eta_{fin} \sim L_c^{\frac{3}{2}} \left(\frac{h}{kA_p} \right)^{\frac{1}{2}} = L_c \left(\frac{h}{kt} \right)^{\frac{1}{2}}$$

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255

$$Re_x = \frac{\rho V x}{\mu} = \frac{V x}{\nu}$$

$$Nu_x = \frac{h_x x}{k_f}$$

$$Pr = \frac{\nu}{\alpha} = \frac{\mu c_p}{k}$$

External Forced Convection

$$Nu = C Re_L^m Pr^n$$

Flat Plate, pg. 430

Across Cylinder/Sphere, pg. 442

Across Tube Bank, pg. 446

Internal Forced Convection

$$Nu = C Re_{Dh}^m Pr^n$$

$$D_h = 4 \frac{A_{cross-section}}{perimeter}$$

$$\Delta T_{LM}^* = \frac{T_{in} - T_{out}}{\ln \left(\frac{T_s - T_{out}}{T_s - T_{in}} \right)}$$

$$T_{properties} = \frac{T_{in} + T_{out}}{2}$$

*Use T_{LM} when $T_s = C$

$$q'^{**} = m'c_p (T_{out} - T_{in})$$

**For $q' = C$

$$Nu_{laminar} \approx 0.05 Re Pr D$$

$$Nu_{turbulent} \approx 10 D$$

Flow, pg. 485

Flow, pg. 496

vection

$$Gr_L = \frac{\rho \beta (T_s - T_\infty) L_c^3}{\mu^2}$$

$$Nu = C (Gr_L Pr)^n = C Re^n$$



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