1) Quick summary — when to use which

• LMTD method — use when inlet & outlet temperatures of both streams are known. It gives the mean temperature driving force and is suitable for single-pass shell-and-tube exchangers behaving like true counter- or parallel-flow.
• NTU (effectiveness) method — use when one outlet temperature is unknown or for complex flow arrangements with multiple passes. It's more general and handles different configurations better.

2) Important formulas

Heat duty (energy balance): Q = ■■Cp■(Th,in–Th,out) = ■cCpc(Tc,out–Tc,in)

LMTD method:
ΔTlm = (ΔT1 – ΔT2) / ln(ΔT1 / ΔT2)
where for counterflow: ΔT1 = Th,in – Tc,out, ΔT2 = Th,out – Tc,in
UA = Q / ΔTlm

NTU/Effectiveness method:
Ch = ■■Cp■, Cc = ■cCpc, Cmin = min(Ch, Cc), Cr = Cmin / Cmax
NTU = UA / Cmin
For counterflow: ε = [1 – exp(–NTU(1–Cr))] / [1 – Cr exp(–NTU(1–Cr))]
Q = ε Cmin(Th,in – Tc,in)

3) Worked numerical example

Given:
Hot stream: ■■=1.5 kg/s, Cp■=2000 J/kg·K, Th,in=150°C, Th,out=100°C
Cold stream: ■c=2.0 kg/s, Cpc=4180 J/kg·K, Tc,in=30°C

A) Q = 1.5×2000×(150–100) = 150,000 W
B) Tc,out = 30 + 150000 / (2×4180) = 47.94°C
C) ΔT1 = 150–47.94 = 102.06°C; ΔT2 = 100–30 = 70°C
ΔTlm = (102.06–70)/ln(102.06/70) = 85.02°C
D) UA = Q / ΔTlm = 150000 / 85.02 = 1764 W/K
E) NTU = UA / Cmin = 1764 / 3000 = 0.588; ε = 0.417; Q = 0.417×360000 = 150,000 W (consistent).

4) Notes for shell-and-tube exchangers

• Real exchangers often use a correction factor F for multi-pass or crossflow geometry:
ΔTlm(actual) = F × ΔTlm(ideal).
• F is based on parameters R = (Th,in–Th,out)/(Tc,out–Tc,in) and P = (Tc,out–Tc,in)/(Th,in–Tc,in).
• Typical overall heat-transfer coefficient (U): 200–1000 W/m^{2}K depending on fluids and fouling.
• NTU method avoids correction charts and works well for complex shell-pass arrangements.

5) Practical checklist for design/calculation

1. Determine knowns: inlet/outlet temps or flow rates.
2. Choose method: LMTD if both outlets known; NTU if one outlet unknown.
3. Calculate heat duty (Q) via energy balance.
4. Compute LMTD (apply F if needed) and get UA = Q / ΔTlm.
5. Estimate U and compute A = UA / U.
6. Use NTU method to verify effectiveness.
7. Iterate if parameters (U, flow, geometry) change.