| Problem 1: Isentropic Expansion | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Exit Conditions | P [N/m2] | T [K] | Pt [N/m2] | Tt [K] | u [m/s] | M [~] | Fx [N] | Q [MW] |
| Numerical | 139,570.8 | 315.6 | 140,550.1 | 316.2 | 35.61 | 0.100 | -58,207.5 | ~ |
| Analytical | 139,568.7 | 315.6 | 140,548.0 | 316.2 | 35.61 | 0.100 | -58,206.6 | ~ |

| Problem 2: Rayleigh Heat Addition | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Exit Conditions | P [N/m2] | T [K] | Pt [N/m2] | Tt [K] | u [m/s] | M [~] | Fx [N] | Q [MW] |
| Numerical | 74,600.6 | 1,210.7 | 92,095.3 | 1,285.8 | 388.46 | 0.557 | 0.0 | ~ |
| Analytical | 74,600.6 | 1,210.7 | 92,095.5 | 1,285.8 | 388.47 | 0.557 | 0.0 | ~ |

| Problem 3: Fanno Flow | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Exit Conditions | P [N/m2] | T [K] | Pt [N/m2] | Tt [K] | u [m/s] | M [~] | Fx [N] | Q [MW] |
| Numerical | 56,662.9 | 283.2 | 61,810.1 | 290.3 | 119.62 | 0.355 | 4,035.9 | ~ |
| Analytical | 56,664.7 | 283.2 | 61,811.7 | 290.3 | 119.62 | 0.355 | 4,035.8 | ~ |

| Problem 4: Convective Heat Transfer | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Exit Conditions | P [N/m2] | T [K] | Pt [N/m2] | Tt [K] | u [m/s] | M [~] | Fx [N] | Q [MW] |
| Numerical | 58,646.4 | 1,158.2 | 80,840.3 | 1,269.5 | 472.72 | 0.693 | 892.7 | 8.203 |

| Problem 5a: Isentropic Positive Shaft Work | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Exit Conditions | P [N/m2] | T [K] | Pt [N/m2] | Tt [K] | u [m/s] | M [~] | Fx [N] | Q [MW] |
| Numerical | 19,527,876.2 | 1,294.8 | 19,693,718.7 | 1,297.9 | 79.33 | 0.110 | -85,624.3 | ~ |
| Analytical | 19,522,414.9 | 1,294.8 | 19,688,418.3 | 1,297.9 | 79.38 | 0.110 | -85,588.2 | ~ |

| Problem 5b: Non-Isentropic Positive Shaft Work | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Exit Conditions | P [N/m2] | T [K] | Pt [N/m2] | Tt [K] | u [m/s] | M [~] | Fx [N] | Q [MW] |
| Numerical | 11,504,427.1 | 1,289.0 | 11,786,279.0 | 1,297.9 | 134.05 | 0.186 | -46,643.6 | ~ |

| Problem 6a: Isentropic Negative Shaft Work | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Exit Conditions | P [N/m2] | T [K] | Pt [N/m2] | Tt [K] | u [m/s] | M [~] | Fx [N] | Q [MW] |
| Numerical | 17,102.6 | 173.2 | 21,657.6 | 185.3 | 155.85 | 0.591 | 3,801.6 | ~ |
| Analytical | 17,103.4 | 173.2 | 21,658.9 | 185.3 | 155.86 | 0.591 | 3,801.0 | ~ |

| Problem 6b: Non-Isentropic Negative Shaft Work | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Exit Conditions | P [N/m2] | T [K] | Pt [N/m2] | Tt [K] | u [m/s] | M [~] | Fx [N] | Q [MW] |
| Numerical | 11,991.3 | 163.4 | 18,617.7 | 185.3 | 209.71 | 0.818 | 5,358.3 | ~ |

| Problem 7: Isentropic Shaft Work w/ Convection | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Exit Conditions | P [N/m2] | T [K] | Pt [N/m2] | Tt [K] | u [m/s] | M [~] | Fx [N] | Q [MW] |
| Numerical | 4,421.3 | 724.7 | 549,197.4 | 2,874.2 | 2,078.05 | 3.851 | -1,664.7 | -1 |