--------------------------------Uncertainty Analysis--------------------------------

$\omega_X = \pm\sqrt{\left(\frac{\partial X}{\partial x_1}\,\omega_{x_1}\right)^2 + \left(\frac{\partial X}{\partial x_2}\,\omega_{x_2}\right)^2 + \left(\frac{\partial X}{\partial x_3}\,\omega_{x_3}\right)^2 + \ldots + \left(\frac{\partial X}{\partial x_n}\,\omega_{x_n}\right)^2}$	$\delta_x = \pm(\frac{x_{max}-x_{min}}{2})$

--------------------------------Marcet Boiler--------------------------------

$\left(\frac{dP}{dT}\right)_{sat} = \frac{h_{fg}}{T v_{fg}} = \frac{s_{fg}}{v_{fg}}$	$\left(\frac{dP}{dT}\right)_{sat} = \frac{P_{i+1}-P_i}{T_{i+1}-T_i}$	$\left(\frac{dP}{dT}\right)_{sat} = \frac{P_{i+1}-P_{i-1}}{T_{i+1}-T_{i-1}}$	$\left(\frac{dP}{dT}\right)_{sat} = \frac{P_{i-1}-P_i}{T_{i-1}-T_i}$
$ln\left(\frac{P_2}{P_1}\right)_{sat} \cong \frac{h_{fg_1}}{R_{steam}}\left(\frac{1}{T_1}-\frac{1}{T_2}\right) \cong \frac{T_1 s_{fg}}{R_{steam}}\left(\frac{1}{T_1}-\frac{1}{T_2}\right)$		$P = P_{gauge} + P_{atm}$	$T\,(K) = T\,(C) + 273.15$

--------------------------------Mechanical Equivalent of Heat--------------------------------

$\tau = r\,g(M+p-m)$	$W = \frac{2\pi\, r\, N\, g\left(M + \frac{p}{1000} - \frac{m}{1000}\right)}{1000}$	$J = \frac{W}{Q}$	$Q = (M\,C\,\Delta T)_{drum} + (M\,C\,\Delta T)_{water}$

--------------------------------Single Stage Air Compressor--------------------------------

$\dot{W}_{m,in} = V * I$	$\dot{W}_{m,out} = \frac{F\,N_1}{K}$, $k = 43.41$	$N = \frac{N_1}{3}$	$V_{S_1} = \frac{\pi}{4}d^2 S$
$\dot{W}_{C_{in}} = \eta_{coupling} * \dot{W}_{m,out}$	$\dot{W}_{C,Isothermal} = \dot{m}_a R_1 T_1 ln\left(\frac{P_2}{P_1}\right)$	$\dot{W}_{C,Ind} = \bar{P}_m V_{S_1} n_c\left(\frac{N}{60}\right)$	
$\bar{P}_m = \frac{Diagram\ Area}{Diagram\ Length} * 20\ \frac{kPa}{mm}$	$\eta_{motor} = \frac{\dot{W}_{m,out}}{\dot{W}_{m,in}}$	$\eta_{isothermal} = \frac{\dot{W}_{C,Isothermal}}{\dot{W}_{C_{Ind}}}$	$\eta_{vol} = \frac{\dot{m}_a}{\rho_a V_{S_1} n_c\left(\frac{N}{60}\right)}$
$\dot{m}_a = 0.002012\, d_o^2\sqrt{\frac{h_m P_1}{T_1}}$	$\eta_{Mechanical} = \frac{\dot{W}_{C,Isothermal}}{\dot{W}_c}$	$\eta_{Overall} = \frac{\dot{W}_{C,Isothermal}}{\dot{W}_E}$	

--------------------------------Flow Through Nozzle--------------------------------

$\frac{P^*}{P_0} = \left(\frac{2}{K+1}\right)^{\left(\frac{K}{K-1}\right)}$	$\frac{T^*}{T_0} = \left(\frac{2}{K+1}\right)$	$\frac{\rho^*}{\rho_0} = \left(\frac{2}{K+1}\right)^{\left(\frac{1}{K-1}\right)}$	$M_a = \frac{V}{C}$
$V = \sqrt{\frac{2\,K\,R\,T_0}{K-1}\left[1-\left(\frac{P_t}{P_0}\right)^{\left(\frac{K-1}{K}\right)}\right]}$	$\dot{m} = A\,P_0\left(\frac{P_t}{P_0}\right)^{\frac{1}{K}}\sqrt{\frac{2\,K}{(K-1)\,R\,T_0}\left[1-\left(\frac{P_t}{P_0}\right)^{\left(\frac{K-1}{K}\right)}\right]}$		$C = \sqrt{K\,R\,T}$
$\frac{dA}{A} = -\frac{dV}{V}(1-M_a^2)$	$\frac{dA}{A} = \frac{dP}{\rho V^2}(1-M_a^2)$	$\frac{dA}{A} = \frac{d\rho}{\rho}\left(\frac{1-M_a^2}{M_a^2}\right)$	
$\frac{T_o}{T} = 1 + \left(\frac{K-1}{2}\right)M_a^2$	$\frac{P_o}{p} = \left[1+\left(\frac{K-1}{2}\right)M_a^2\right]^{\left(\frac{K}{K-1}\right)}$	$\frac{\rho_o}{\rho} = \left[1+\left(\frac{K-1}{2}\right)M_a^2\right]^{\left(\frac{1}{K-1}\right)}$	

--------------------------------Specific Heat Ratio for air--------------------------------

$\frac{P_2}{P_1} = \left(\frac{P_2}{P_3}\right)^{\frac{K}{K-1}}$	$K = \frac{ln\left(\frac{P_1}{P_2}\right)}{ln\left(\frac{P_1}{P_3}\right)}$	$P = \gamma H_m + P_{atm}$	$P_2 = P_{atm}$	$\gamma = \rho g$

--------------------------------Air and Water Heat Pump--------------------------------

$\dot{Q}_{cmp} = \dot{m}_w \times Cp_w \times (T_6 - T_5)$	$\dot{Q}_{cond} = \dot{m}_w \times Cp_w \times (T_7 - T_6)$	$\dot{Q}_T = \dot{Q}_{cmp} + \dot{Q}_{cond}$
$COP_{HP} = \frac{\dot{Q}_{cond}}{W}$	$COP_{HP} = \frac{\dot{Q}_T}{W} = \frac{\dot{Q}_{cond}+\dot{Q}_{cmp}}{W}$	$COP_{HP} = \frac{Q_H}{W} = \frac{\dot{m}_r \times (h_2 - h_3)}{\dot{m}_r \times (h_2 - h_1)} = \frac{(h_2 - h_3)}{(h_2 - h_1)}$

Air Cooler and Heat Pump

$\dot{m}_{air} = 0.00105\sqrt{\frac{H_a P_a}{T_2}}$	$(COP_R)_{max} = \frac{T_L}{T_H - T_L}$	$COP = \frac{\dot{Q}}{\dot{W}_{in}}$	$(COP_{HP})_{max} = \frac{T_H}{T_H - T_L}$
$\dot{Q} = \dot{m}_a\left(h_{final} - h_{initial}\right)$	$h = h_{dry\_air} + \omega h_{vapor}$	$h_{dry\_air} = C_{P_{air}} T$	$h_{vapor} = h_g@(T)$

$(COP_R)_E = \frac{\dot{m}_a[(h_1 - h_2) + (\omega_1 h_{v1} - \omega_2 h_{v2})]}{E_c + E_f}$	$(COP_R)_E = \frac{\dot{m}_a[(h_1 - h_2) + (\omega_1 h_{v1} - \omega_2 h_{v2})] - \dot{m}_c C_{P_w} T_c}{E_c + E_f}$
$(COP_R)_I = \frac{\dot{m}_a[(h_1 - h_2) + (\omega_1 h_{v1} - \omega_2 h_{v2})] - E_f}{E_c}$	$(COP_R)_{max} = \frac{\left[\frac{(T_1 + T_2)}{2}\right]}{\left[\frac{(T_3 + T_4)}{2} - \frac{(T_1 + T_2)}{2}\right]}$
$(COP_R)_I = \frac{\dot{m}_a[(h_1 - h_2) + (\omega_1 h_{v1} - \omega_2 h_{v2})] - \dot{m}_c C_{P_w} T_c - E_f}{E_c}$	$(COP_R)_{I\,max} = \frac{T_{10}}{T_6 - T_{10}}$

$(COP_{HP})_{max} = \frac{\left[\frac{(T_1 + T_2)}{2}\right]}{\left[\frac{(T_1 + T_2)}{2} - \frac{(T_3 + T_4)}{2}\right]}$	$(COP_{HP})_{max} = \frac{T_9}{T_9 - T_8}$	

$(COP_{HP})_E = \frac{\dot{m}_a[(h_2 - h_1) + (\omega_2 h_{v2} - \omega_1 h_{v1})]}{E_c + E_f}$	$(COP_{HP})_I = \frac{\dot{m}_a[(h_2 - h_1) + (\omega_2 h_{v2} - \omega_1 h_{v1})] - E_f}{E_c}$

Refrigeration Unit

$P_s = T \times \omega = F \times r \times \frac{2\pi \times n_C \times 1.98}{60}$	$P_f = F_f \times r \times \frac{2\pi \times n_C \times 1.98}{60}$	$P_i = P_s - P_f$
$P_h(h) = \dot{m}_r \times (h_2 - h_1)$	$\dot{Q}_{rad+conv} = P_s - \dot{m}_R \times (h_2 - h_1)$	$\dot{Q}\ e,1 = Obtained\ from\ digital\ wattmeter$
$\dot{Q}\ e,2\ (h) = \dot{m}_r \times (h_1 - h_4)$	$\dot{Q}\ c,1 = \dot{m}_w \times C_{pw}(t_6 - t_5)$	$\dot{Q}\ c,2(h) = \dot{m}_r \times (h_2 - h_3)$
$COP_{R,act} = \frac{\dot{Q}_L}{W_{com}} = \frac{\dot{m}_r \times (h_1 - h_1)}{\dot{m}_r \times (h_2 - h_1)}$		

Thermal Power Plants

$\dot{Q}_H = \dot{m}_s(h_{out} - h_{in})$	$\dot{E}_f = \dot{m}_f Q_{cv}$	$\dot{E}_{th} = \dot{m}_f Q_{cv} \eta_c$
$\eta_{SG} = \frac{\dot{Q}_H}{\dot{E}_{th}}$	$\dot{W}_T = \dot{m}_s(h_{in} - h_{out})$	$\dot{W}_{Shaft} = \tau\omega$
$\eta_{Coupling} = \frac{\dot{W}_{Shaft}}{\dot{W}_{net}}$	$\dot{W}_E = V\ I$	$\eta_{Gen} = \frac{\dot{W}_E}{\dot{W}_{Shaft}}$
$\dot{Q}_L = \dot{m}_s(h_{in} - h_{out})$	$\dot{Q}_{CW} = \dot{m}_{CW}(h_{out} - h_{in})$	$\eta_{Cond} = \frac{\dot{Q}_{CW}}{\dot{Q}_L}$
$\dot{W}_p = \dot{m}_s(h_{in} - h_{out})$	$\dot{W}_{net} = \dot{W}_T - \dot{W}_p$	$\eta_{max} = 1 - \frac{T_L}{T_H}$

Revision on Air-Vapor Mixture and Psychrometry

$H = H_a + H_v = m_a h_a + m_v h_v$	$\omega = \frac{m_v}{m_a} = 0.622\,\frac{P_v}{P_a} = \frac{0.622\,P_v}{P - P_v}$	$\Phi = \frac{m_v}{m_g} = \frac{P_v}{P_g}$

$\Phi = \frac{\omega\ P}{(0.622 + \omega)P_g}$	$\omega = \frac{0.622\Phi P_g}{P - \Phi P_g}$	$h = h_a + \omega h_g$	$\dot{V} = \dot{m}_a\ v$	$P = P_a + P_v$

$h_v(T, Low\ P) \cong h_g(T) = 2500.9 + 1.82\,T \quad T\ is\ in\ C$	$P_g = P_{sat}@T$	$T_{dp} = T_{sat}@P_v$

$\dot{Q} = \dot{m}_a\ (\Delta h)$ for Simple Heating or Simple Cooling	$\dot{m}_w = \dot{m}_a\left(\omega_f - \omega_i\right)$
$\dot{Q} = \dot{m}_a\ (\Delta h) - \dot{m}_w h_w$ for cooling with Dehumidification;	