

# ME 161

## Introduction to Mechanical Engineering

### Lec Note 1: Brig Gen Humayun

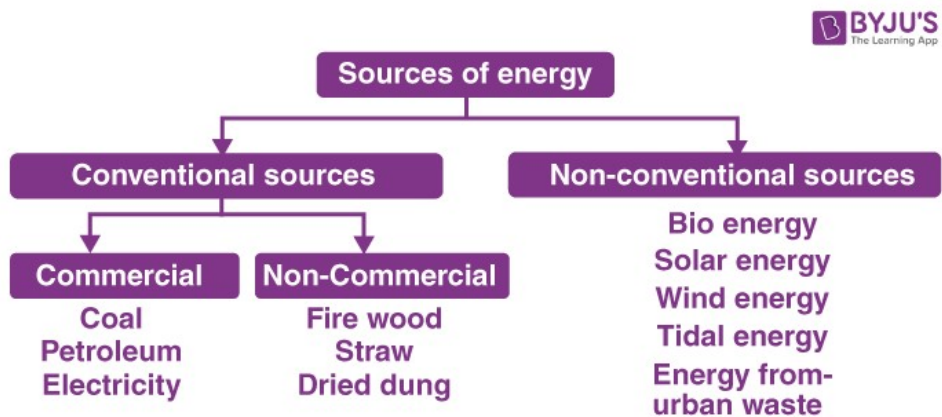
## Major Energy Sources

Please go through class notes and reference materials discussed in the class. This is just a guideline for those who missed the classes

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## Government focus on power plant vision 2041

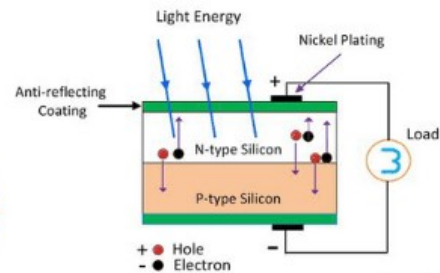
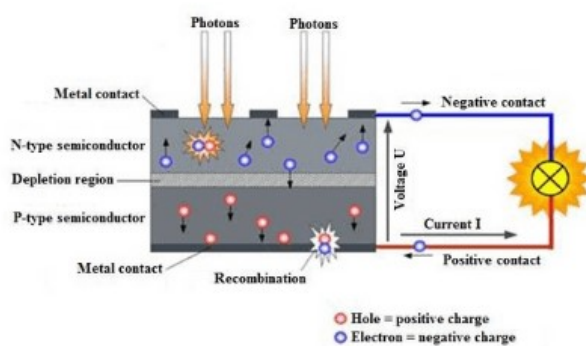
- 5 points as discussed in class

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## What is the Working Principle of Solar Cell and Photovoltaic Cell?


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## What is the Wind Power Equation?

$$Power = \frac{1}{2} \times \rho \times \pi \times r^2 \times C_p \times CF \times v^3 \times NG \times NB$$

P = power generated in Watts

v = velocity of the wind in m/s

$\rho$  = density of the wind in kg/m<sup>3</sup>

$\pi r^2$  = swept area, where r = blade length in m

$C_p$  = Power Coefficient

$C_f$  = Capacity Factor

$N_g$  = generator efficiency

$N_b$  = gearbox efficiency

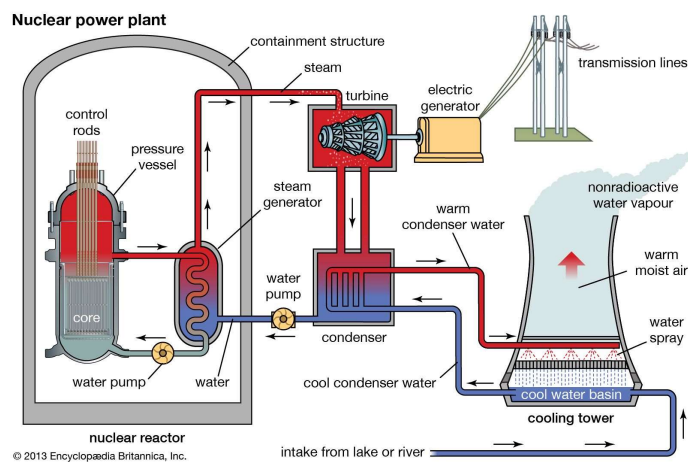


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## Nuclear power plant

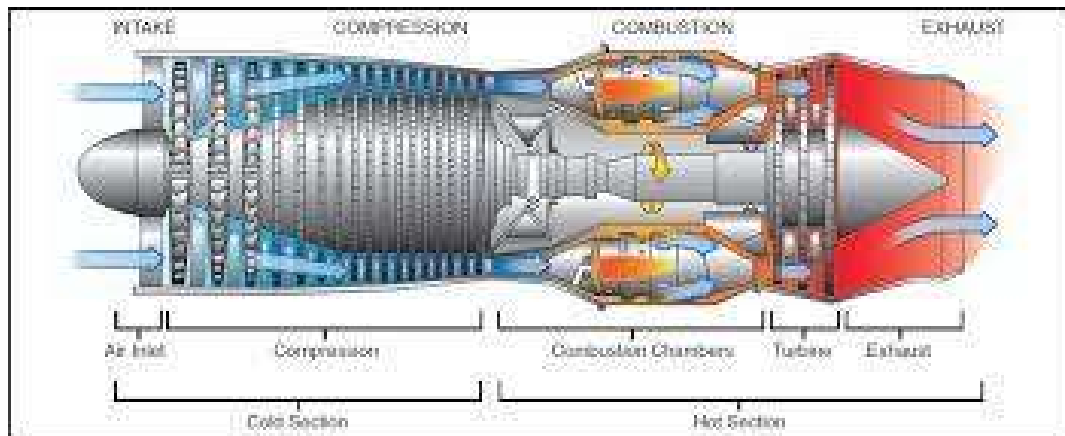


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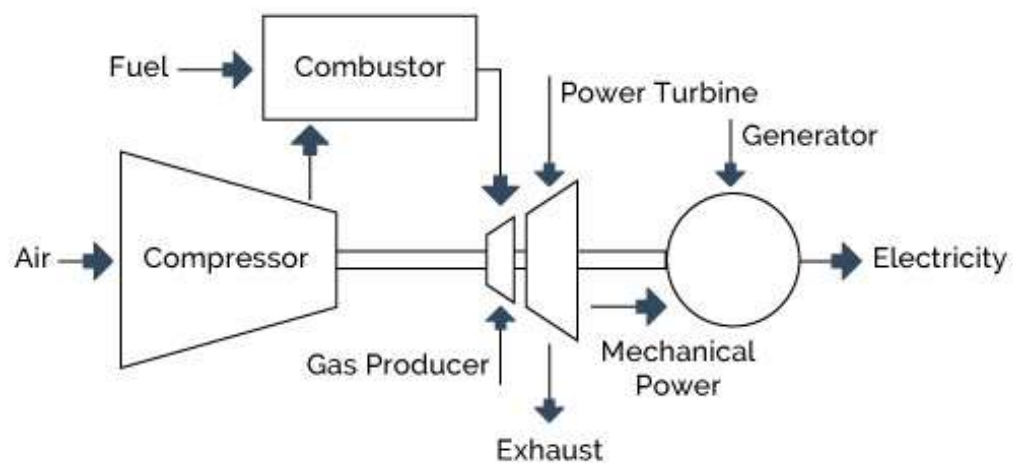
## Components of Gas turbine



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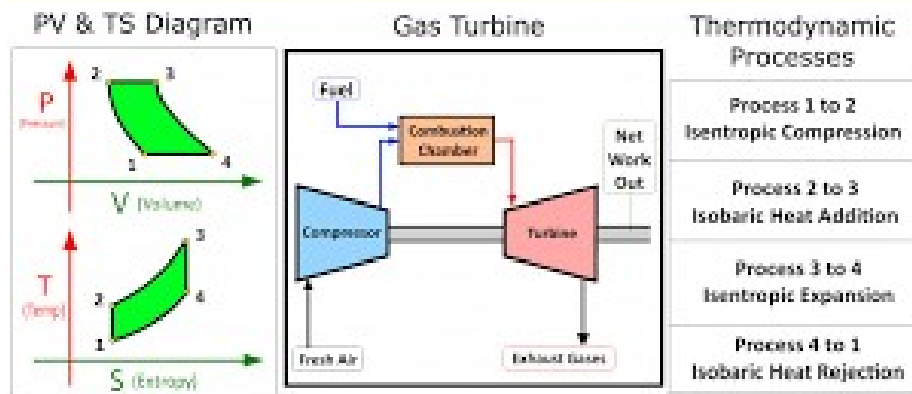


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## Brayton Cycle (or Joule Cycle)

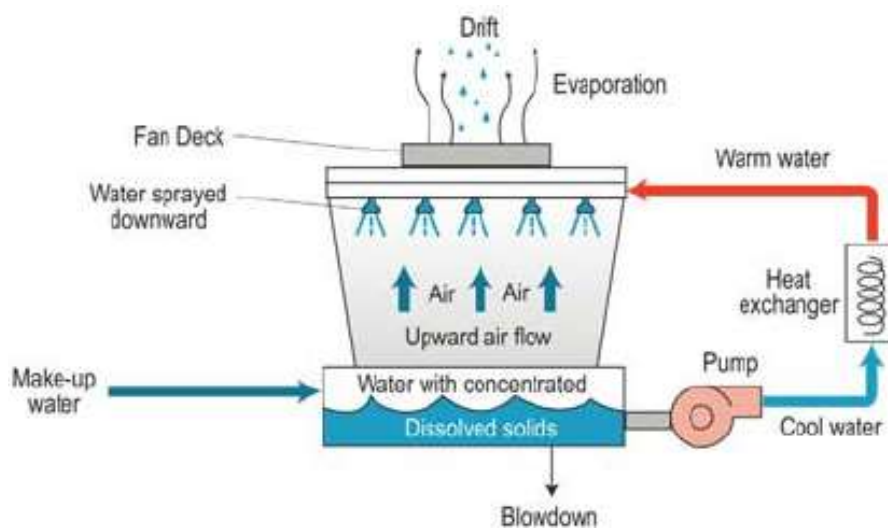


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### Cooling Tower

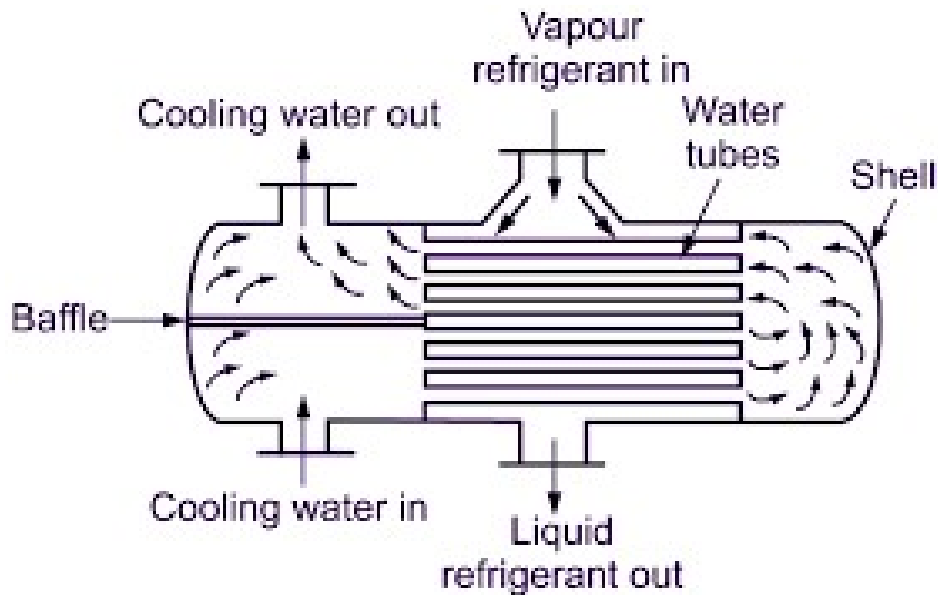


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## SHELL AND TUBE TYPE HEAT EXCHANGER

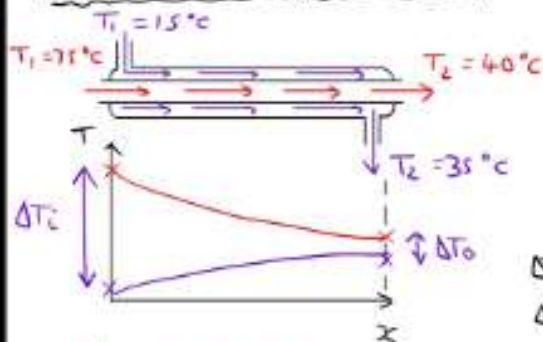


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## HEAT EXCHANGER (SHELL &amp; TUBE):



$$h_1 = 400 \text{ W/m}^2\text{K}$$

$$h_2 = 1100 \text{ W/m}^2\text{K}$$

$$D = 8 \text{ mm}$$

$$L = 15 \text{ m}$$

$$\Phi = \dot{m} C_p (T_2 - T_1)$$

$$\Phi = UA(LMTD)$$

$$LMTD = \frac{\Delta T_o - \Delta T_i}{\ln(\Delta T_o / \Delta T_i)}$$

$$\Delta T_i = 75 - 15 = 60^\circ\text{C}$$

$$\Delta T_o = 40 - 35 = 5^\circ\text{C}$$

$$LMTD = \frac{5 - 60}{\ln(5/60)} = 22.134^\circ\text{C}$$

$$\frac{1}{U} = \frac{1}{h_1} + \frac{1}{h_2} \quad \frac{1}{U} = \frac{1}{400} + \frac{1}{1100}$$

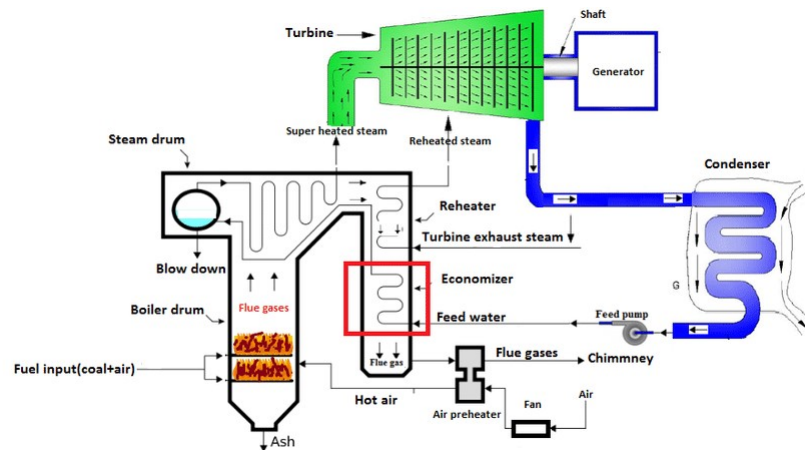
$$\frac{1}{U} = 3.409 \times 10^{-3} \quad U = 293.33 \times 10^3 \text{ W/m}^2\text{K}$$

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## Heat Exchanger units in a coal based power plant



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## Properties of a coal

Parameter	Coal	Manure
Moisture	10.8%	36.61%
Ash	5.68%	25.25%
Volatile Matter	52.8%	31.57%
Fixed Carbon	30.72%	6.57%
Heat Value(DAF) kJ/kg	26535	7865
Carbon	54.9%	19.24%
Hydrogen	4.33%	2.22%
Oxygen	23.2%	14.68%
Nitrogen	0.76%	1.47%
Sulfur	0.34%	0.53%

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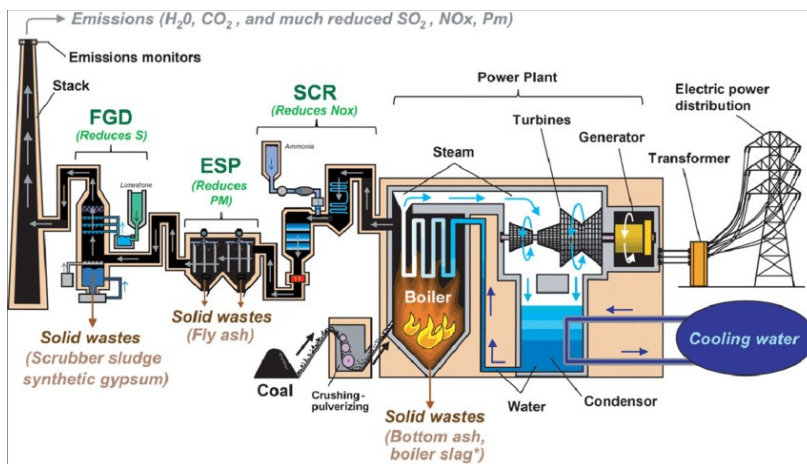
- Remember the possibilities for combustion equations.
- Fuel + oxygen = carbon dioxide + water (*complete combustion*)
- Fuel + oxygen = carbon + water (*incomplete combustion producing soot*)
- Fuel + oxygen = carbon monoxide + water (*incomplete combustion producing toxic gas*)
- Fuel + oxygen = carbon monoxide + carbon + water (*incomplete combustion producing soot + toxic gas*)

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## Environmental protection measures in coal based power plant



Name of Monitored Parameters	Monitored Parameter	Unit
Emissions	SO <sub>x</sub>	mg/Nm <sup>3</sup>
	NO <sub>x</sub>	mg/Nm <sup>3</sup>
	CO	mg/Nm <sup>3</sup>
	Particulate Matter	mg/Nm <sup>3</sup>
Water Temperature	Temperature	°C
Waste Management	Fly Ash and Bottom Ash	Kg / year

FGD, ESP, SCR ??? Find out

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