# TUTORIAL PROBLEMS

1. A generating station has an overall efficiency of 15% and 0.75 kg of coal is burnt per kWh by the station.

Determine the calorific value of coal in kilocalories per kilogram. [7644 kcal/kg]

# TotoMal set 1

#### Totorial #1

Poverall = 15% = 0.15

Coal Consumption per Kush = 0.75 Kg

We have to determine Calonific value of Coal

Let X be the Calonific value of coal

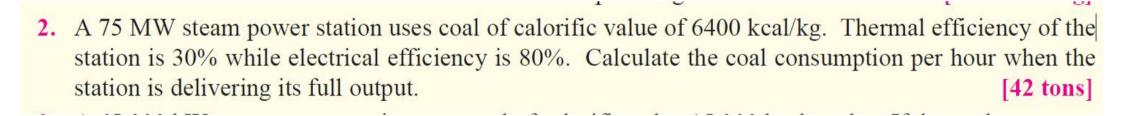
Heat Produce by 0.75 Kg of Coal = 0.75 x X Kcal

Heat equivalent of 1 Kush = 860 Kcal

Poverall = Electrical output in heat units

Heat of Combustion

$$0.15 = 860$$
 $0.75 \times$ 



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Totorial # 2
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```
generation/Max demand = 75000 Kcal /kg
         Nelectrical = 0.8
         Assume load Factor is 1
        Noverall = Nymeronal × Nelectrical
              = 0.3 x 0.8
              = 0.24
        Units generated per hour = 75000 x1 x1 Kwh
                              = 75000 kwh
       Heat equivalent of 1 Kwh = 860 Kcal
       Heat equivalent of 75000 kwh = 860 x 75000
                                    = 64500000 Kcal
        Heat produce per hour = Electrical output in heat unit
                                      Noveral
                           = 64500000
                                0.24
                           = 268750000 Kcal
      Coal Consumption per hour = 268750000
                             = 41992.2 kg
                             ≈ 42 tons
```

3. A 65,000 kW steam power station uses coal of calorific value 15,000 kcal per kg. If the coal consumption per kWh is 0.5 kg and the load factor of the station is 40%, calculate (i) the overall efficiency (ii) coal consumption per day.

[(i) 28.7% (ii) 312 tons]

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Totorial #3
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Electricity generation = 65000 KW

Calonific Value = 15000 Kcal/kg

Coal Consumption per Kwh = 0.5 Kg

Load factor = 40% = 0.4

(i) overall efficiency (ii) Coal Consumption per day

units generated per hour = 65000 x0.4 x1

= 26000 kWh

units generated per day = 26000x 24 = 624000 kWh

Coal Consumed for 1 kWh = 0.5 kg

Coal Consumed for 624000 kWh = 312000 kg

Daily Coal Consumption = 312 tons

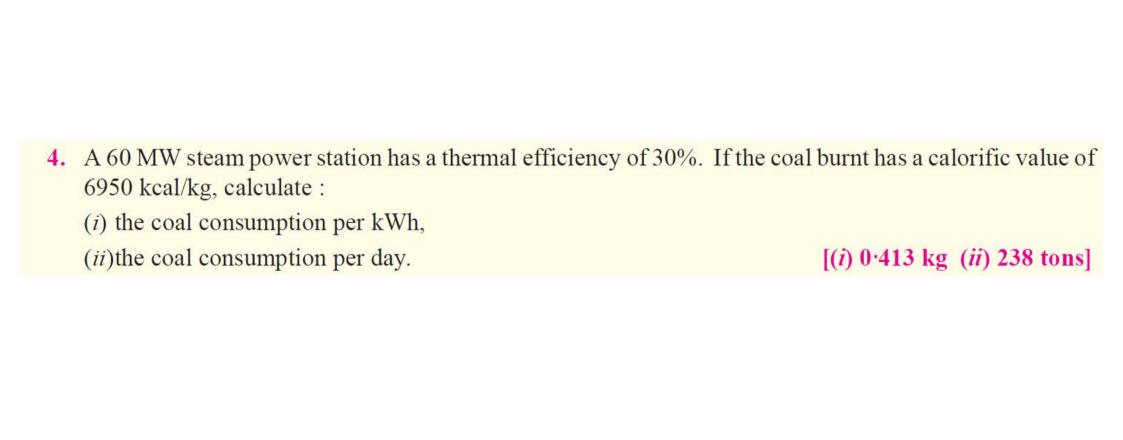
Heal produce per day = Electrical output in heat units X24

Normall = 65000 x 24 x 860 312000 x 15000

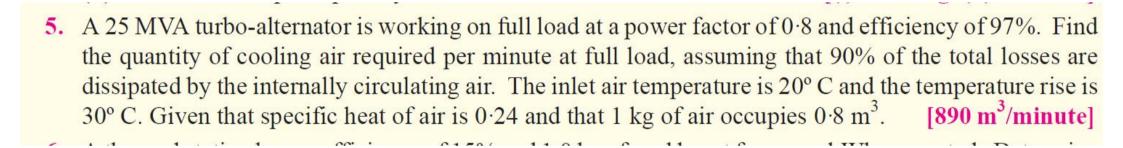
> = 134160000 468000000

= 0.287

Novall = 28.7 %



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Totorial #4
      output power = 60 MW
         1 1 = 30 / = 0.3
      input power = 60 = 200 MW
         1 Kcal = 4184 J
 As we Know
        1 KCQX = 41090
6950 KCal = 29.0788 X/0 J
      Ikg Coal produce 29.0788 MJ
 Clear that
  Also
        1 KWh = 1×103 W x 3600 S
                 = 3600 X103 WS
                 = 3.6 ×10° J
        1 kg coal - 29.0788 MJ
        x kg coal → 3.6 x 10 J
        2 × 29.0788 MJ = 3.6 MJ
            x = 0.124 kg
    Energy consumed per day = 200 x103 x 24 kwh
                            = 4800 × 103 KWh
        1 Kwh - > 0.124 Kg
   4800 X103 KWh -> X Kg
                    X = 595.2 × 103 Kg
```



#### Potorial #5

Rating of alternator = 25 MVA

P. f = 0.8

N = 97 / = 0.97

Intel air temp= 20°C

Emp Nise 
$$\Delta T = 30°C$$

Specific heat =  $C = 0.24$  BTU = 1 KJ/Kg°C

1 Kg occupies 0.8 m³

Tutput power =  $P = SCos \phi = 25(0.8) = 20$  MW

Input power =  $\frac{20}{0.97} = 20.62$  MW

Power losses = Input power - Output power

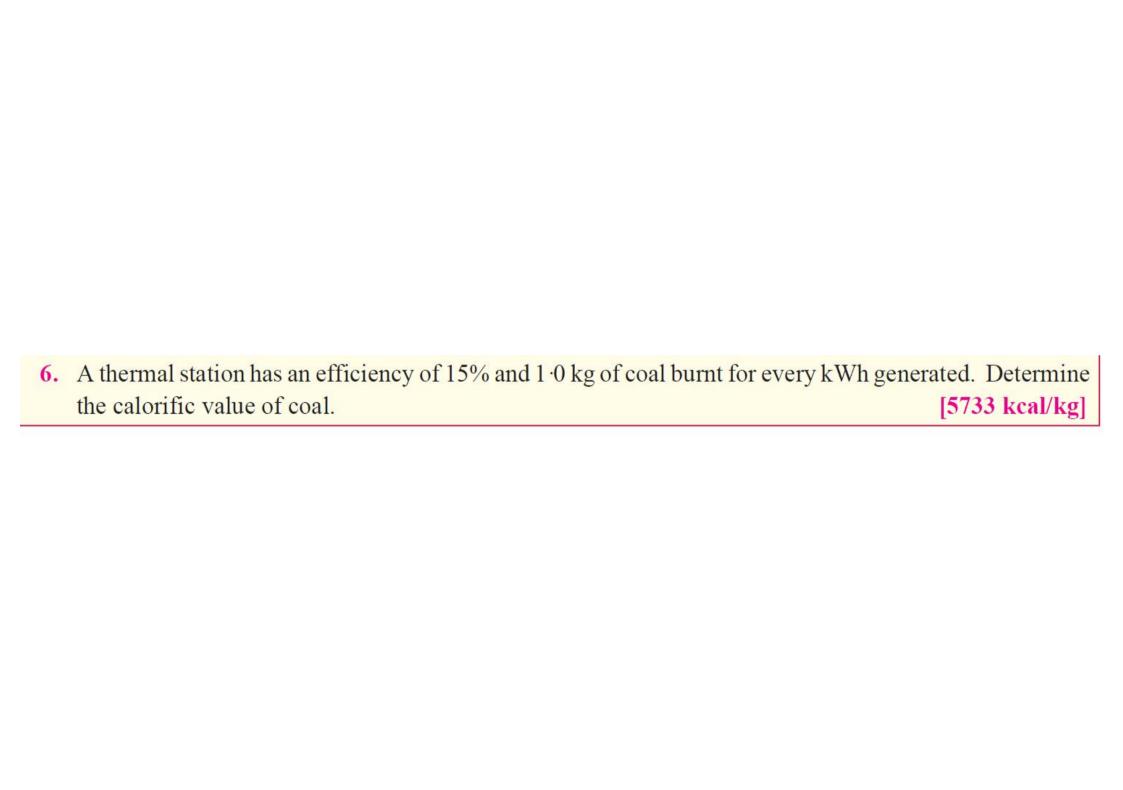
= 0.61855MW

90% of total loss are dissipated by internal circulating air & heat transfer

ALSO

$$Q = mcst$$

$$556.7 = m(1 \text{ kJ/kg°c})(30°c)$$
  
 $m = 18.56 \text{ kg/s} = 1 \text{ kg occupies } 0.8 \text{ m}^3$   
 $18.56 \text{ kg occupies} = (0.8)(18.56) = 14.848 \text{ m}^3/\text{s}$ 



#### Potonial # 6

Coal burn per Kwh = 1 kg

we have to determine calonific value of coal

let x be the calonific value of Coal

Heat produce by 1 kg of coal = 1-x Kcal

Heat equivalent of 1 kwh = 860 Kcal

$$\chi = \frac{860}{0.15}$$

# SET 2

## TUTORIAL PROBLEMS

A hydro-electric station has an average available head of 100 metres and reservoir capacity of 50 million cubic metres. Calculate the total energy in kWh that can be generated, assuming hydraulic efficiency of 85% and electrical efficiency of 90%.
 [10.423 × 10<sup>6</sup> kWh]

# Totolal set 2

#### Tutorial # 1

Evicial #1

H=100 m

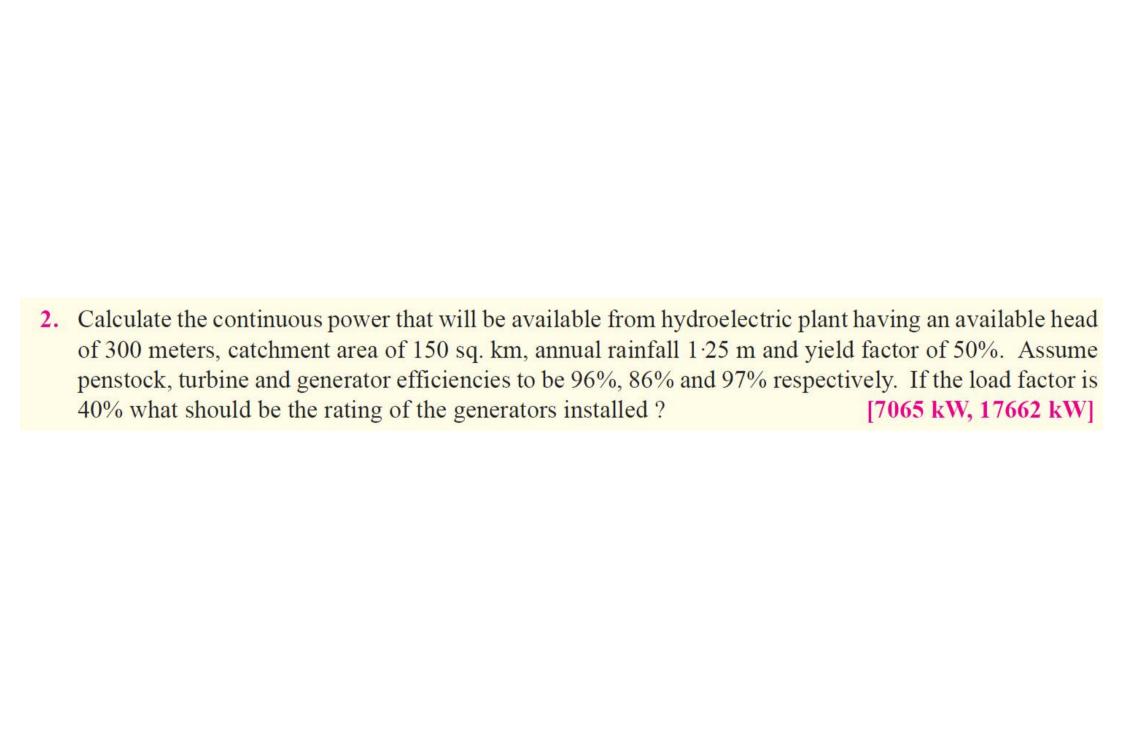
Reservoir capacity = 
$$50 \times 10^6$$
 m<sup>3</sup>
 $A_{tydrawhic} = 85\% = 0.85$ 
 $A_{electrical} = 90\% = 0.9$ 
 $A_{overall} = 0.85 \times 0.9 = 0.765$ 

Weight of water =  $W = Volume$  of water  $\times$  density

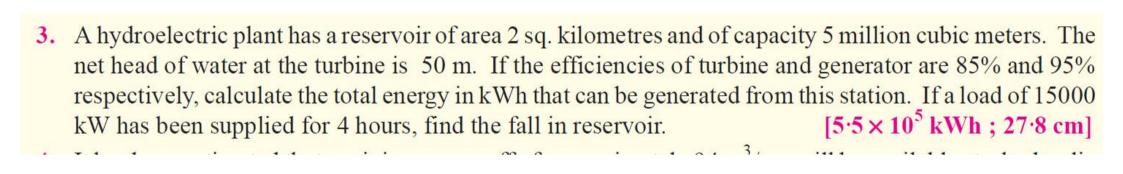
 $= (50 \times 10^9) \times 1000 \text{ kg}$ 
 $= 50 \times 10^9 \text{ Kg}$ 

1 kg =  $9.81 \text{ N}$ 
 $W = 490.5 \times 10^9 \text{ N}$ 

Electrical energy generated =  $(490.5 \times 10^9) (100) (0.765)$ 
 $= 3752325 \times 10^7 \text{ km/s}$ 
 $= 3752325 \times 10^7 \text{ km/s}$ 
 $= 10.423 \times 10^6 \text{ km/s}$ 



```
Utorial #2
        H= 300 m
  Catchment alea = 150 Km2 = 150 (1000) m
                 = 1.5x108 m2
 Annual vainfall = 1.25m
yield factor = 50 1/. = 0.5
        Pensteck = 96% = 0.96
        1 turbine = 86% =0.86
       Ngenerated = 97% = 0.97
  => Poroel = 0.96 x 0.86 x 0.97 = 0.800832
        load factor = 40% = 0.4
 volume of water = (1.5 \times 10^8 \times 1.25 \times 0.5) = 9.3 \times 10^7 \text{ m}^3
  weight of water = W= 9.375×107 × 1000
(available)
                      W = 9.375 x 1010 Kg
                      W= 9.375 x100 x 9.81 N
                      W=9.196875 X10" N
  Electrical energy available = 9.196875 x10" x 300 x 0.800832
                              = 2-30954554 × 10" Nm or watt se
                             = 220954554 x10"4 KWh
                             = 61376265 kwh
      Average Power
                           = 61376265
                               8760
                           = 7006.4 Kwh
max demand = Average load = 7006.4
load Pactor 0.4
                   = 17516-1 KW
                                      17516.1 KW
    Rating of generator must be
```

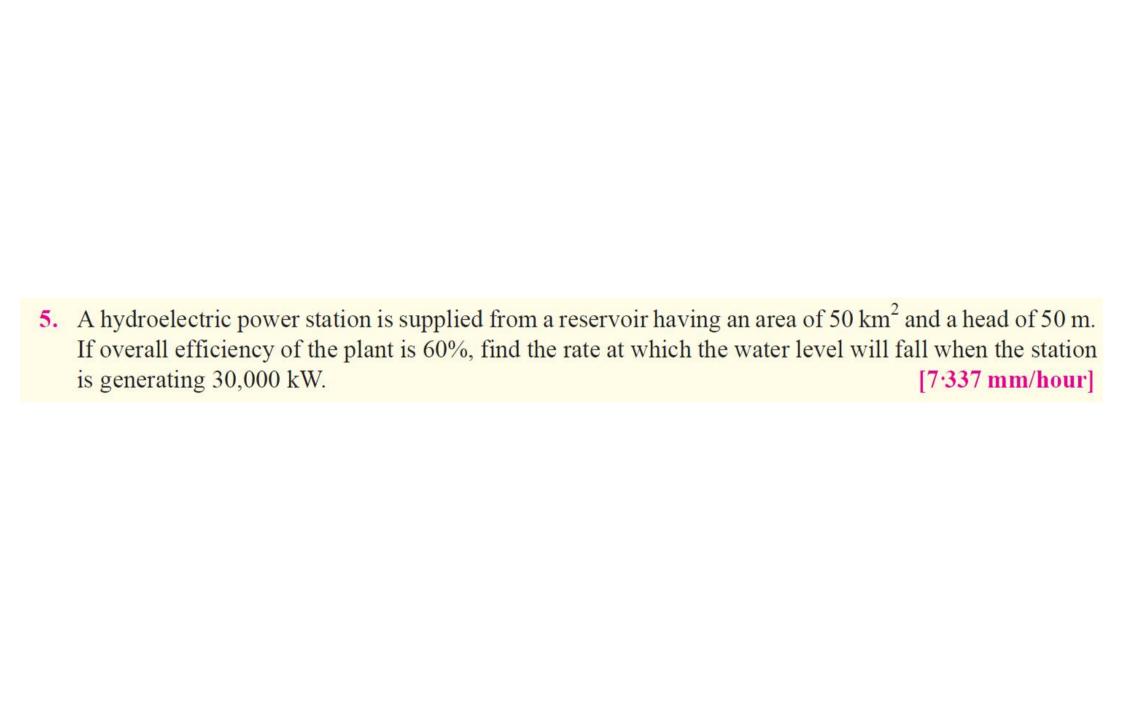


### Tutorial #3

4. It has been estimated that a minimum run-off of approximately 94 m³/sec will be available at a hydraulic project with a head of 39 m. Determine the firm capacity and yearly gross output.

 $[3600 \text{ kW}, 315.36 \times 10^6 \text{ kWh}]$ 

*Hint.* Wt. of water flowing/sec = 
$$\frac{94 \times (100)^3}{1000}$$
 kg



# Tutorial # 4

Weight of water available =  $W = 94 \times 1000 \times 9.81$  N W = 923140 N H = 39 m Work done/sec =  $WH = 923140 \times 39$  Watt = 35963.460 KW  $\Rightarrow 90000$  Plant capacity

Film capacity for 100% efficiency = 35963.460 KW

Yearly gross of P = Firm Capacity x Hours in year = 35963.460 x 8760

= 315.04 x 106 kwh

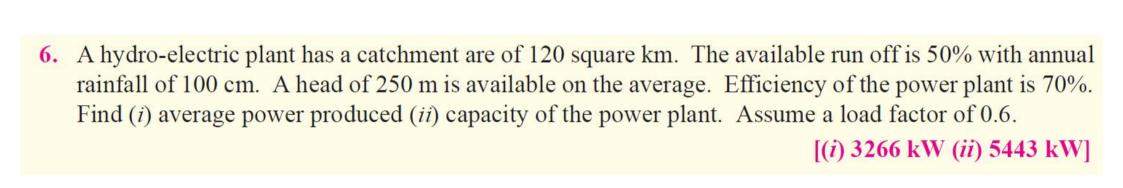
#### Tutorial #5

Area =  $50 \, \text{Km}^2 = 50 \, \text{NO}^6 \, \text{m}^2$   $H = 50 \, \text{m}$   $1_{\text{lowere}} = 60 \, \text{/} = 0.6$ Output power =  $30,000 \, \text{kW}$ input power =  $\frac{30,000}{0.6} = 50,000 \, \text{kW}$ 

let x be the tate; when water level goes down in one se

 $50 \times 10^6 = 1000 \times 9.81 \times 50 \times 50 \times 10^6 \text{ m}$  $\Rightarrow x = 2.04 \times 10^{-6} \text{ m/s}$ 

$$x = 2.04 \text{ Hm/s}$$
  
 $x = 7.334 \text{ mm/h}$ 



(i)  

$$V = (120 \times 10^{4})(1)(0.5) = 6 \times 10^{7} \text{ m}^{3}$$
  
 $W = (6 \times 10^{7})(1000)(9.81) \text{ N}$   
 $= 5.886 \times 10^{11} \text{ N}$   
Energy available =  $(5.886 \times 10^{11})(250)(0.7)$   
 $= 1.03 \times 10^{11} \text{ Watt sec}$   
 $= 28612500 \text{ Kwh}$   
Average Power =  $\frac{28612500}{2760}$   
 $= 3266.3 \text{ KW}$