Shishir

University of Asia Pacific
Department of Electrical and Electronic Engineering
Semester Final Examination, Fall' 2021
Program: B.Sc. in EEE (4^{th} Year/1^{st} Semester)

Course Code: EEE-411
Time: 3 Hours

Course Title: Power Station Engineering

Credit Hours: 3 Hours
Full Marks: 150

[Answer any six questions. **Including Question 1, Question 4, Question 7, Question 8**]

✓1. (a). Why is electrical energy preferred over other forms of energy? [05]

(b). Discuss the different sources of energy available in nature. [10]

(c). Mechanical energy is supplied to a d.c. generator at the rate of 4200 J/s. The generator delivers 32·2 A at 120 V. [10]
(i) What is the efficiency of generator?
(ii) How much energy is lost per minute of operation?

2. (a). Draw a neat schematic diagram of a hydro-electric plant and explain the functions of various components. [15]

(b) It has been estimated that a minimum run off of approximately 94 m^3/sec will be available at a hydraulic project with a head of 39 m. Determine (i) firm capacity (ii) yearly gross output. Assume the efficiency of the plant to be 80%. [10]

Or

✓3. (a) Draw the schematic diagram of a nuclear power station and discuss its operation. [15]

(b) What is the power output of a $_{92}U^{235}$ reactor if it takes 30 days to use up 2 kg of fuel? Given that energy released per fission is 200 MeV and Avogadro's number = $6{\cdot}023 \times 10^{26}$ per kilomole. [10]

4. (a) What do you understand by the load curve? What informations are conveyed by a load curve? [4+4]

(b) A 100 MW power station delivers 100 MW for 2 hours, 50 MW for 6 hours and is shut down for the rest of each day. It is also shut down for maintenance for 45 days each year. Calculate its annual load factor. [10]

(c) Explain the term diversity factor. How do these factor influence the cost of generation? [07]

5. (a) Discuss the various methods of determining the depreciation of the equipment. [25]

Or

✓6. (a) Explain how the load factor plays a vital role in determining the cost of energy. [10]

(b) The equipment in a power station costs Tk 15,60,000 and has a salvage value of Tk 60,000 at the end of 25 years. Determine the depreciated value of the equipment at the end of 20 years on the following methods : [15]
(i) Straight line method
(ii) Diminishing value method
(iii) Sinking fund method at 5% compound interest annually.

7. (a) What do you understand by tariff? Discuss the objectives of tariff. [07]

(b) Describe the desirable characteristics of a tariff. [08]

(c) The maximum demand of a consumer is 20 A at 220 V and his total energy consumption is [10]

8760 kWh. If the energy is charged at the rate of 20 paise per unit for 500 hours use of the maximum demand per annum plus 10 paise per unit for additional units, calculate : (i) annual bill (ii) equivalent flat rate.

8. (a) What do you mean by renewable energy? Explain how wind energy is converted into electrical power. [20]

(b) What is biomass? [05]

Fall-21

FINAL

Q-(a) why is electrical energy preferred over forms of energy?

1->(a)

Ans: Electrical energy is superior to all of other form of energy due to the following reason:-

① Convinent Form:- Electrical energy is a very convinent form of energy. It can be easily converted into other forms of energy. electrical energy can be converted into light (electrical bulb), mechanical energy (electrical motor) etc.

② Easy control: The electrically operated machines have simple and convinent starting, control and operation. An electrical motor can be started or stopped by turning on or off a switch.

③ greater flexibility :- one important reason for preferring electrical energy is the flexibility that it offers. It can be easily transported from one place to another with the help of conductors.

④ cheapness :- Electrical energy is much cheaper than other forms of energy. To use this forms of energy for domestic, commercial and industrial purpose.

⑤ cleanliness :- Electrical energy is not associated with smoke, fumes or poisonous gases. Its use insures cleanliness and healthy conditions.

⑥ High transmission efficiency :- The consumers of electrical energy are generally situated quite away from the centers of its production.

— x —

Source of energy :-

1. The sun.
2. " wind.
3. water.
4. fuels.
5. nuclear energy.

1. The sun :- The sun is the primary source of energy. The heat energy radiated by the sun can be focussed over a small are by means of reflectors. This heat can be used to raise steam and electrical energy can be produced with the help of turbine - alternator combination.

2. water : when water is stored at a suitable place it possesses potential energy because of the heat created. This water energy can be converted into mechanical energy with the help of water turbines. The water turbine drives the alternator in mechanical into Electrical energy

Fules:

(iv) The main source of of energy are fuels. Solid fuel as coal, liquid fuel as oil and gas fuel as natural gas.

(v) nuclear energy: Towards the end of second world war, it was discoverd that large amount of heat energy is liberated by the fission of uranium and fissionable materials.

(vi) The wind: This method can be used where the wind blows for a considerable length of time. The wind energy is used to run the wind mill which drives a small generator.

1-(c) MATH: Mechanical energy is supplied to a d.c generator at the rate of 4200 J/s. The generator delivers 32.2 A at 120 V.

Ex-1.1

(1) What is the efficiency of generator?

(2) How much energy is lost per minute of operation?

Solve:

(I) Input power, $P_i = 4200\ J/S = 4200\ W$

output ", $P_o = \boxed{EI} = 120 \times 32.2$

$= 3864\ W$

$\therefore$ Efficiency, $\boxed{\eta = \frac{P_o}{P_i} \times 100}$

$= \frac{3864}{4200} \times 100$

$= 92\%$

(II) power lost, $P_L = P_i - P_o = 4200 - 3864$

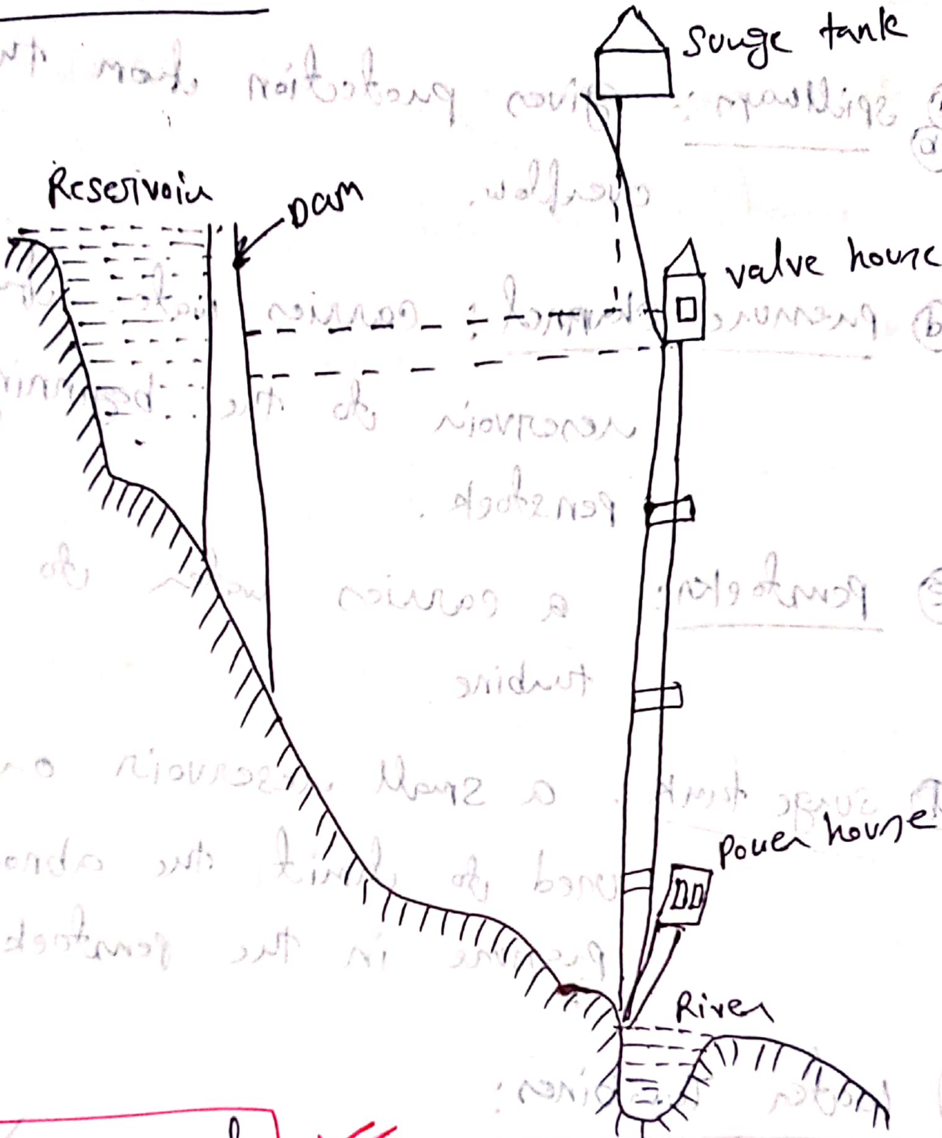
$= 336\ W$

$\therefore$ Energy lost per minute 60 s of operation

$= P_L \times t = 360 \times 60 = 20160\ J$

AD:

2-@ * Schematic Arrangement of Hydro-electric power station / plant.



main component

① Hydraulic structures.

ⓐ Dams or Barrier :- barrier which store water and creates water head. 50-100 m dams are created by earth but high head dams created by RCC.

ⓑ ⓒ Reservoir: stores water if the water availability is uneven.

ⓒ ⓑ spillways: gives protection from the water overflow.

ⓓ pressure channel: carries water from reservoir to the beginning of penstock.

ⓔ penstocks: a carries water to the turbine.

ⓕ surge tank: a small reservoir or tank used to limit the abnormal pressure in the penstock.

② Water Turbines:

ⓐ impulse Turbines: (pelton turbine)

* used for high head.
* the entire pressure of water is converted into kinetic energy in a nozzle and the velocity of the jet drives the wheel.

ⓑ Reaction Turbine: (francis and kaplan turbine)

* used for low medium head.
* Guide blades control the flow of water

③ Electrical Equipments:

The electrical equipment of hydro-electric power station includes alternators, transformers, circuit breakers and other switching and protective devices.

2 → 6 MATH

Ex-2.7

It has been estimated that a minimum run off approximately 94 m^3/sec will be available at a hydraulic project with a head of 39m.

① Firm capacity

② yearly gross output.

Assume the efficiency of the plant to be 80%.

Solve:

weight of water, $W = 94 \times 1000$

$= 94000$ kg/sec

water Head, $H = 39m$

work done/sec $= W \times H$

$= 94000 \times 39$

$= 35.963 \times 10^3$ W

$= 35.963$ KW

(i) Firm capacity = plant efficiency × gross plant capaci[ty]

$= 0.80 \times 35,963$

$= 28,770$ KW

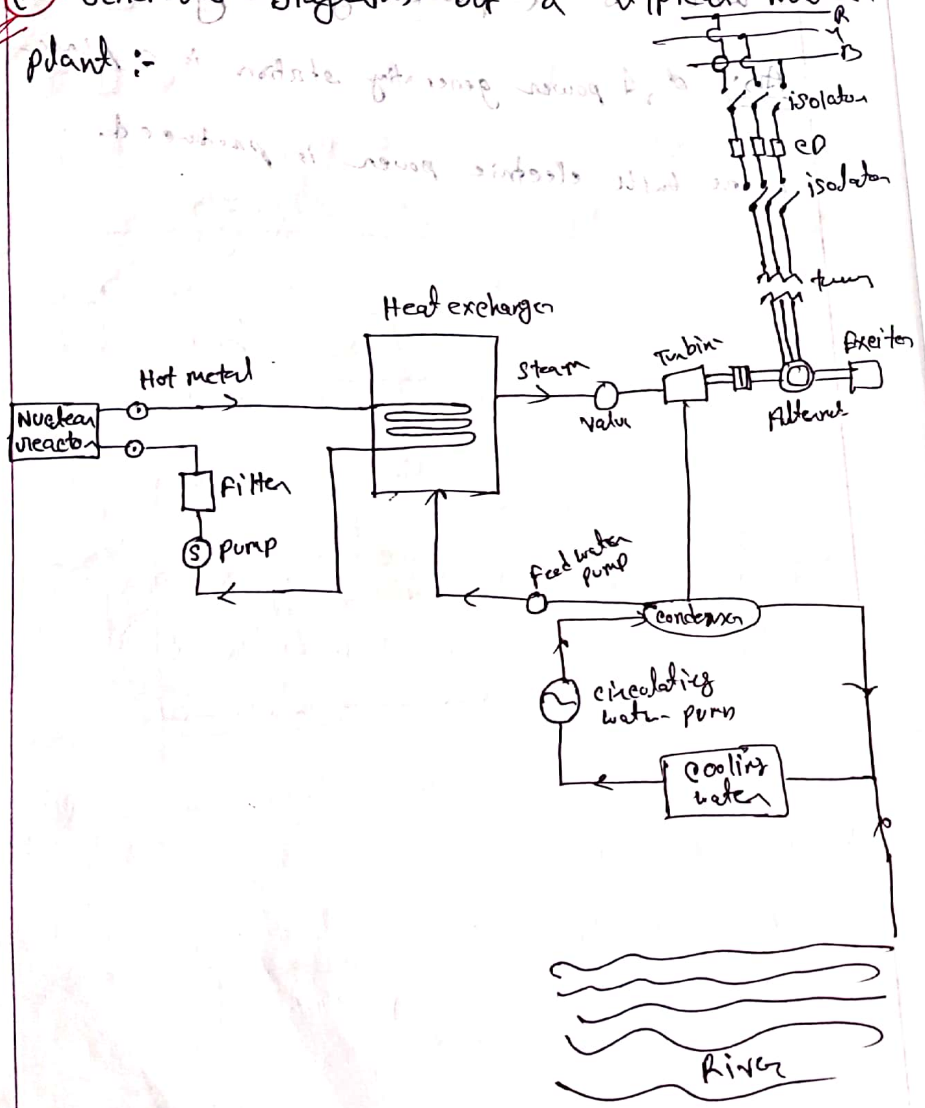
(ii) yearly gross output = firm capacity × Hours in year

$= 28,770 \times 8760$

$= 252 \times 10^6$ KWh

CamScanner

3 → a (*) Schematic Diagram of a typical Nuclear plant :-



operations :-

(*) Heavy elements such as uranium (U-235) or Thorium (Th-232) are subjected to nuclear fission in a special apparatus known as a reactor.

(*) Heat energy released is utillized in raising steam at high temperature and pressure.

(*) The steam runs the steam turbine which converts steam energy into mechanical energy.

* Last Topic → Types of loads → chapter-3

page-8 :

MATH

3 → b wath is the power output of a $_{92}U^{235}$ reactor if it take 30 days to use up 2kg of fuel? given that energy relased per fission is 200 mev and Avogadro number $= 6.023 \times 10^{26}$ per kilomole.

Ex-2.18

Solve:-

Number of atoms in 2kg fuel $= \frac{2}{235} \times 6.023 \times 10^{26}$

$= 5.12 \times 10^{24}$

These atoms fission in 30 days.

$$= \frac{5.12 \times 10^{24}}{30 \times 24 \times 60 \times 60} = 1.975 \times 10^{18}$$

Energy relased per fission $= 200$ mev

$= (200 \times 10^{6}) \times (1.6 \times 10^{-19})$

$= 3.2 \times 10^{-11}$ J

$\therefore$ power output P is,

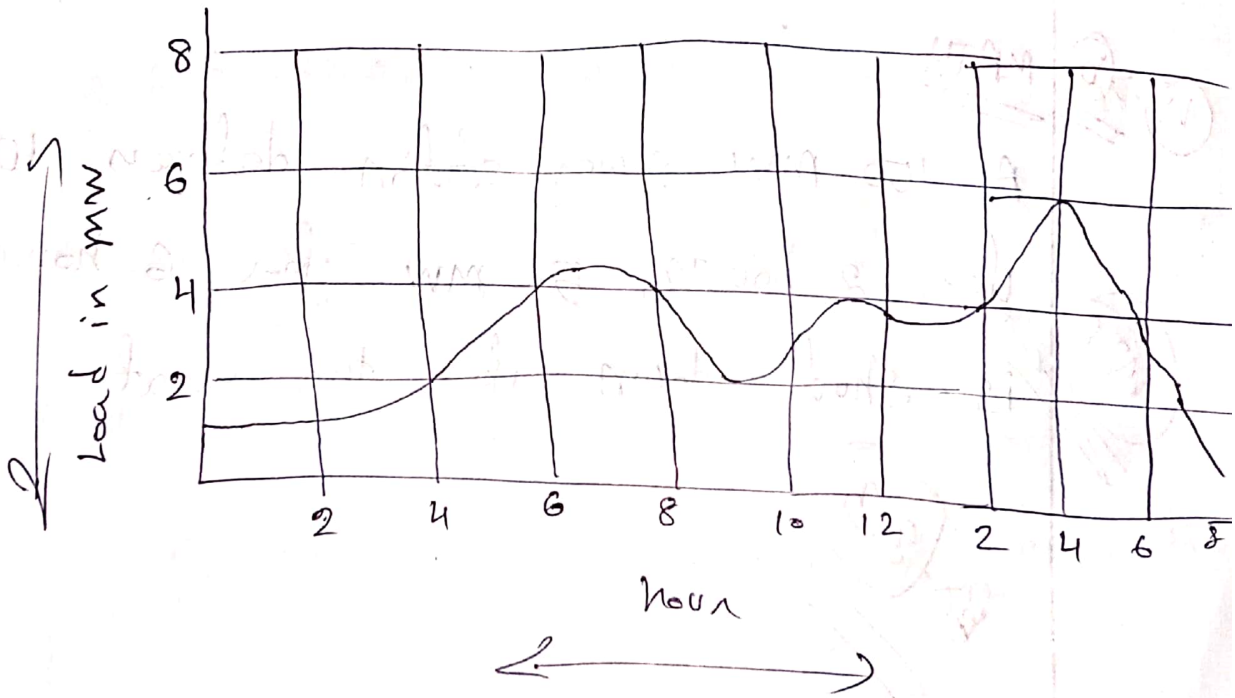
$P = (3.2 \times 10^{-11}) \times (1.975 \times 10^{18})$ W

$= 63.2 \times 10^{6}$ W $= 63.2$ MW

4 → a Q→ what do you understand by the load curve? what information are conveyed by a load curve?

Ans:-

The curve showing the variation of load on the power station with respect to time is known as a load curve.



Information of load curve:-

* It shows the variations of load on the

power station during different hours of the day.

* The area under the daily load curve gives the number of units generated in the day.

* The load curve helps in selecting the size and number of generating units.

4 → (b) MATH

A 100 MW power station delivers 100 MW for 2 hours, 50 MW for 6 hours and is shut down for the rest

MID

Ex-3.3

4 → (c) Q:- Explain the term diversity factor. How do these factor influence the cost of the equipment?

Ans:-

Diversity factor:- The ratio of the sum of individual maximum demands to the maximum demands on power station is known as diversity factor.

$$\text{Diversity factor} = \frac{\text{sum of individual max. demand}}{\text{max. demand on power station}}$$

A power station supplied load to various types of consumers whose maximum demands generally do not occurs at the same time. Therefore, the maximum demand on the power station is always less than the sum of individual maximum demands of consumer. So diversity factor will always be greater than 1. The greater the diversity factor, the lesser is the cost of generation of power.

complete

6 → a Q:- Explain how the load factor plays a vital role in determining the cost of energy.

Ans:- The ratio of average load to the maximum demand during a given period is known as load factor.

$$\text{Load factor} = \frac{\text{Average load}}{\text{max. demand}}$$

If the plant is in operation for T hours

$$\text{Load factor} = \frac{\text{Average load} \times T}{\text{max. demand} \times T}$$

$$= \frac{\text{Unit generated in T hours}}{\text{max. demand} \times \text{T hours.}}$$

The load factor may be daily load factor, monthly load factor or annual load factor if the time period considered is a day or month or year. Load factor is always less than 1 because average load is smaller than the maximum demand.

The load factor plays key role in determining the overall cost per unit generated. Higher the load factor of the power station, lesser will be cost per unit generated.

⑥→ⓑ MATH

Ex-4.3

The equipment in a power station costs TK 15,60,000 and has a salvage value of TK 60,000 at the end of 25 years. Determine the value of equipment at the end of 20 years on the following method:

① straight line method

② Diminishing value method

③ Sinking fund method at 5% compound interest annualy.

Solve:

Initial cost of equipment, $P = Rs\ 15,60,000$

Salvage value of " , $S = Rs\ 60,000$

Useful life $n = 25$ years.

① straight line method,

$$\text{Annual depreciation} = \frac{P-S}{n}$$

$$= \frac{15,60,000 - 60,000}{25}$$

$$= Rs\ 60,000$$

value of equipment after 20 years,

$$= P - \text{Annual depreciation} \times 20$$

$$= 15,60,000 - 60,000 \times 20$$

$$= Rs,\ 3,60,000$$

(ii) Diminsing value method,

$$\text{Annual unit depreciation, } x = 1 - (S/P)^{1/n}$$

$$= 1 - \left(\frac{60,000}{15,60,000}\right)^{1/25}$$

$$= 1 - 0.878 = 0.122$$

value of equipment after 20 years.

$$= P - (1-x)^{20}$$

$$= (15,60,000\ (1-0.122)^{20}$$

$= Rs\ 1,15,615$

(iii) Sinking fund method,

Rate of interest $r = 5\% = 0.05$

Annual deposit in the sinking fund is,

$$q = (P-S)\left[\frac{r}{(1+r)^n - 1}\right]$$

$$= (15,60,000 - 60,000)\left[\frac{0.05}{(1+0.05)^{25} - 1}\right]$$

$= Rs\ 31,433$

$\therefore$ Sinking fund at the end of 20 years

$$= q\,\frac{(1+r)^{20} - 1}{r}$$

$$= 31,433 \times \frac{(1\times 0.05)^{20} - 1}{0.05}$$

$= Rs\ 10,39,362$

$\therefore$ value of plant after 20 years

$= Rs\ (15,60,000 - 10,39,362)$

$= Rs\ 5,20,638.$

7 -> (a) Tariff : The rate at which electrical energy is supplied to a consumer is known as tariff.

objective of tariff :-

① Recovery of cost of producing electrical energy at the power station.

② Recovery of cost on the capital investment in transmission and distribution systems.

③ Recovery of cost of operation and maintenane of supply of electrical energy, metering equipment, billing etc.

④ A suitable profit on the capital investment.

7 → 6) ~~Describe~~

Desirable characteristics of tariff:-

A tariff must have the following desirable characteristics:

① **Proper return:-** The tariff should be such that it ensure the proper return from each consumer. This will ~~ea~~ enable the electric supply company to ensure continious and reliable service to the consumers.

② **Fairness:-** The tariff must be fair so that different types of consumers are satisfied with the rate of charge of electrical energy. Thus a big consumer should be charged at a lower rate than a small consumer.

(iii) simplicity :- The tariff should be simple so that an ordinary consumer can easily understand it.

(iv) Reasonable profit :- The profit element in the tariff should be reasonable. An electric supply company is a public utility company and generally enjoys the benefits of monopoly.

(v) Attractive :- The tariff should be attractive so that a large number of consumers are encouraged to use electrical energy.

(7)→(c) MATH

Ex. 5.2 The maximum demand of a consumer is 20 A at 220 V and his total energy consumption is 8760 kWh. If the energy is charged at the rate of 20 paise per unit for 500 hours use of the maximum demand per annum plus 10 paise per unit for additional units, calculate

(i) annual bill

(ii) equivalent flat rate.

Solve :-

Assume the load factor and power factor to be unity

$$\therefore \text{maximum demand} = \frac{220 \times 20 \times 1}{1000}$$

$$= 4.4 \text{ kW}$$

(i) units consumed in 500 hours $= 4.4 \times 500$

$= 2200$ kWh

Chage of 2200 kwh $= Rs\ 0.2 \times 2200$

$= Rs\ 440$

Remaining units $= 8760 - 2200$

$= 6560$ kwh

Chage of 6560 kwh $= Rs\ 0.1 \times 6560$

$= Rs\ 656$

$\therefore$ Total annual bill $= Rs\ (440 + 656)$

$= Rs\ 1096$

(ii) equivalent flat rate $= Rs\ \frac{1096}{8760}$

$= Re\ 0.125$

$= 12.5$ paise

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5 → chapter - 4 → slide - এর page - 3

4.4 →

$\frac{125}{150}$ → complete

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