KNOWLEDGE INSTITUTE OF TECHNOLOGY

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COURSE PLAN

POWER PLANT ENGINEERING

Department of Mechanical Engineering

UNIT I
COAL BASED THERMAL POWER PLANT

PART - A

1. Name the four major circuits in steam power plant.

- Coal and ash circuit
- Air and flue gas circuit
- Feed water and steam circuit
- Cooling water circuit

2. What consists of air and flue gas circuit?

Air and flue gas circuit consists of forced draught fan, air-pre-heater, boiler, furnace, super heater, economizer, dust collector, induced draught fan and chimney.

3. What consists of feed water and steam flow circuit in steam power?

The feed water and steam flow circuit consists of feed pump, economizer boiler drum super heater, turbine and condenser.

4. What consists of cooling water circuit and coal & ash circuit in steam power plant?

The cooling water circuit consists of a pump, condenser and cooling tower. The coal and ash circuit consists of coal delivery, preparation of coal, handling of coal to the boiler furnace, ash handling and ash storage.

5. What is the main purpose of the reservoir?

The main purpose of reservoir is to store water received from catchments areas during the rainy seasons and supply the same during the dry season.

6. What is the main purpose of the dam?

The main purpose of the dam is to increase the height of water level and also to increase the working head of the hydraulic power plant.

7. Why trash rack is used?

The trash rack is used to prevent the entry of debris, which might damage the turbine runners and chock up the nozzle of impulse turbine.

8. What is the use of surge tank?

The surge tank is used to provide better regulation of water pressure in the system. The surge tank controls the water when the load on the turbine decreases and supplies water when the load on the turbine increases. Thus, surge tank controls the pressure variations resulting from the rapid changes in water flow in penstock and hence prevents water hammer.

9. What is the function of Fore bay?

Fore bay is considered as naturally provided surge tank. It is temporary water storage when the load on the plant is reduced and provides water for initial increment on increasing load.

10. Explain about penstock?

The pipe between surge tank and prime mover is known as penstock. It is designed to withstand high pressure. It is made up of reinforced concrete. In very cold areas, the penstock is buried to prevent ice formation and to reduce the expansion joints.

11. What is the use of spill Ways?

Spillway is like a safety valve of the dam. It discharges major flood without damaging the dam. It keeps the reservoir level below the maximum level allowed.

12. Write about prime movers?

Prime mover converts the kinetic energy of water into mechanical energy to produce electrical energy. Pelton wheel, turbine, Francis turbine, Kaplan turbine and Propeller turbine are prime movers used in hydraulic power plants.

13. What are the uses of air filter and superchargers in diesel engine power plant?

The purpose of air filter is to filter the air from dust and other suspended particles. The purpose of super charger is to increase the pressure of the engine to increase power of the engine.

14. What is the use of draft tube?

The draft tube is used to regain the kinetic energy of water coming out of reaction turbine. It enables the reaction turbine to be placed over tailrace level.

15. What is the function-of cooling system in Diesel power plant?

The function of cooling system is to remove heat from the engine cylinder to keep the temperature of the cylinder in low range and extend engine life.

16. What consists of lubrication system in diesel engine power plant?

The lubrication system consists of oil pumps, oil tanks, filters, coolers and connecting pipes. The purpose of the lubrication is to reduce the friction of moving parts and also pipes to reduce the wear and tear of moving parts.

17. What is the purpose of intercooler in gas turbine power plant?

Since the power required to compress the air is less in isothermal process it is required to maintain the, temperature of air constant as far as possible. Hence the air leaving the L.P. compressor is cooled by intercooler and then passed to the H.P compressor.

18. Name two combined power cycles?

- Combined cycle of gas turbine and steam power plant.
- Combined cycle of gas turbine and diesel power plant.

19. Define turbo charging in combined gas turbine and diesel cycles?

In the combined cycle, the exhaust gas from the diesel engine is expanded in the turbine, which is coupled with compressor which supplies pressurized air to the diesel engine. This increases diesel engine output. This arrangement is known as turbo charging.

20. What is the main purpose of high-pressure boilers?

The high-pressure boilers are used to increase the efficiency of the plant and to reduce the cost of electricity production.

21. State important advantages of high-pressure boilers?

- The amount of scale formation is less, since the velocity of water through pipes are more.
- All parts of the system are heated uniformly, so there is no danger of overheating.

22. Name important high pressure boilers?

- La Mont boiler
- Benson boiler
- Loeffler boiler
- Velox boiler.

23. Write about La Mont boiler? What is the major disadvantage of La Mont boiler?

La Mont boiler is a forced circulation high pressure water tube boiler.

The major disadvantage is the formation of bubbles, salt and sediment on the inner surfaces of the heating surfaces. This reduces the heat flow and steam generation.

24. Write about Benson boiler? State some important advantages of Benson boiler?

Benson boiler is the high pressure, vertical fire tube boiler. This boiler has no drum and is ~designed to operate at critical pressure of 225 bar. Benson boiler has no drum. So the total weight of the Benson boiler is reduced by-20%, when compared to other boilers.

- The erection of Benson boiler is easier and quicker.

25. Write about Loeffler boiler?

The major disadvantage in La Mont boiler is the deposition of salt and sediment on the inner surface of the water tubes. It reduces the heat transfer and ultimately the steam generating capacity.

In Loeffler boiler, this problem is solved by preventing water from flowing through the boiler tubes. The steam is generated outside the tubes.

26. Explain Reheat cycle?

If the dryness fraction of steam leaving the turbine is less than 0.88, then, corrosion and erosion of turbine blades occur. To avoid this situation, reheat is used.

In the reheat cycle, the expansion of steam takes place in one (or) more-turbines. Steam is expanded in the HP turbine first, and then it is reheated. The reheated steam is again expanded in. the LP turbine.

27. What are the important advantages of Re-heating?

- Due to reheating, network done increases
- Heat supply increases
- Thermal efficiency increases
- Due to reheating, the turbine exit dryness fraction increases so moisture decreases - so blade erosion becomes minimum - so life of the turbine will be increased.

28. Name different methods of reheating?

(a) Gas Reheating
(b) Live - steam reheating
(c) Combined gas live steam reheater.

29. Define bleeding in steam power plant?

Assume I kg of steam is expanded in the turbine. Before complete amount of steam -is expanded, some amount of steam (m kg) is -extracted ' Extracting the steam in the turbine before exhaust is called bleeding. This bled steam is used to heat the feed water.

30. Explain the term Regeneration?

Regeneration means heating the feed water by steam taken from the turbine. The steam is exhausted (bled) from the turbine at several locations before exhaust and is supplied to regenerator (feed water heater) to heat the feed water.

31. State some advantages of Regeneration cycle?

- Heat supplied to boiler becomes reduced
- Thermal efficiency is increased since the average temperature of heat addition to the cycle is increased.
- Due to bleeding in the turbine, erosion of turbine due to moisture is reduced.

32. Name different methods used to extract steam for heating the feed water?

- Direct contact heater
- Drain pump method
- All drains to hot well
- Cascade system

33. Define the term waste heat recovery?

Waste heat is the heat which is not at all used and exhausted out as a waste product. Waste heat is normally available from the industry in the form of process steam and water at high temperature. Also, the waste heat is discharged with the exhaust gases in so many industries. This heat can be recovered for useful purpose. This process is known-as waste heat recovery.

34. What are the waste materials, which can be used for fuel for power generation?

- Municipal waste
- Industrial waste
- Paper waste
- Rubber waste.

35. Write about waste heat boilers?

The waste heat boilers use the waste heat in gases coming out of diesel engines and gas turbines at high temperature (or) use the waste as a fuel in the incineration.

Some boilers use the industrial dirty gases for power generation.

36. Write about fluidised bed boilers?

When the high velocity gas is passed through a packed bed of finely divided solid particles, the particles become suspended in the gas stream and the packed bed becomes a fluidised bed. When the gas velocity is very high, the fluidised bed become turbulent and rapid mixing of particles occurs. Ultimately, the, behaviour of mixture solid particles and -gas become a fluid. Burning of a fuel in such a state is known as Fluidised Bed Combustion. The boiler plant using this fluidised bed combustion is known as fluidised bed boilers.

37. State some advantages of fluidised bed boilers?

- Any type of fuel - solid, liquid (or) gaseous fuel (or) domestic and industrial waste can be used in FBC system. Any type- of combustible matter can be burned by adjusting the factors as size, air velocity and rate of feed.
- High heat transfer rate is possible to the surfaces immersed in the bed, because solid mixing is extremely possible.
- High combustion efficiency.
- The solid fuel need not be pulverised in fluidised bed boilers.

38. Name the two types of coal handling?

- Out plant handling
- In-plant handling.

39. Write about out-plant handling?

Out plant handling includes the handling of coalmine to the thermal power plant. These handlings are outside the plant in the following ways.

- Transportation by sea (or) river
- Transportation by rail
- Transportation by road
- Transportation of coal by pipeline.

40. Write about inplant handling of-coal?

In order to handle large quantity of coal inside the plant, some mechanical handling systems are provided f6r smooth, easy and better controlled operation. The inplant coal handling is divided, into following categories.

- Coal unloading
- Coal preparation
- Coal transfer
- Coal storage

41. Why the preparation of coal is necessary?

The coal from coal nines cannot be directly fed into the furnace. Proper preparation of coal should be done before feeding the coal to the furnace. In the coal preparation, the coal passes through the different equipments like 1. Crushers 2.Sizers 3.Driers and Magnetic Separators.

42. Name the different types of coal transforming equipments?

1. Belt conveyors 2. Screw conveyors 3. Bucket elevators 4. Grab bucket elevators 5. Skip hoists 6. Flight conveyors.

The coal transfer starts by carrying of coal from-unloading point to the storage site.

43. What is the use of belt conveyors?

Belt conveyors are mostly used for transporting coal over long distance with large quantity. An endless belt is made to run over a pair of end drums and pulleys and supported by series of roller at regular intervals.

44. Define draught, what is the use of draught in thermal power plants?

Draught is defined as a small pressure difference required between the fuel bed (furnace) and outside air to maintain constant flow of air and to discharge the gases through chimney to the atmosphere. Draught can be obtained by chimney, fan, steam jet (or) -air jet (or) combination of these.

The uses are

- To supply required quantity of air to the furnace for combustion of fuel.
- To draw the combustion products through the system.
- To remove burnt products from the system

45. Write about classification of draught?

Draught is classified as

1. Natural draught
2. Artificial draught

The artificial draught is further classified as

(a) Steam jet draught
(b) Mechanical draught
(c) Induced draught
(d) Forced draught

46. Define the term Natural draught and what are the advantages of natural draught system?

The tall chimney creates the natural draught by the temperature difference between hot gases in the chimney and cold atmospheric air outside the chimney.

The advantages are

- No external power is required
- Air pollution is less since gases are discharged at high level.
- No maintenance cost
- Capital cost is less than artificial draught.

47. Write about artificial draught?

In modem power plants, the draught should be flexible to meet the fluctuating loads and it should be independent of atmospheric conditions. To achieve this, the aid of draft fans becomes must and by employing the draft fans, the height of the chimney would be reduced.

48. Write about forced draught system?

In this system, the blower (forced draft fan) is located at the base of the boiler near the grate. Air is forced to the furnace by forced fan and the flue gases are forced to chimney through economiser and air preheater.

49. What are the advantages of forced draught system?

- Since the fan handles cold air, the fan size and the power required are less.
- No need of water cooled bearings because the air being handled is cold air,
- Pressure throughout the system is above atmospheric pressure so the air leakage into the furnace is reduced.

50. How the induced draught is working?

In an induced draught system, a blower (induced draft fan) is placed near (or) at the base of the chimney. The fan sucks the flue gas from the furnace creating a partial vacuum inside the furnace. Thus atmospheric air is induced to flow through the furnace to aid the combustion of fuel. The flue gases drawn by the fan passes through chimney, to the atmosphere.

51. Why the balanced draught system is preferred than other system?

In the induced draught system, when the furnace is opened for firing, the cold air enters the furnace and dilates the combustion. In the forced draught system, when the furnace is opened for firing, the high pressure air will try to blow out suddenly and furnace may stop. Hence the furnace cannot be opened for firing (q) inspection in both, systems. Balanced draught, which is a combination of induced and forced draught, is used to overcome the above stated difficulties.

52. What is the difference between stocker firing and pulverised fuel firing?

The stocker firing method is used for firing solid coal whereas pulverised firing method is used for firing pulverised coal.

53. What are-the different types of stockers?

1. Over feed stockers
   - Travelling grate stockers
   - Spread stockers
2. Under feed stockers
   - Single retort stocker
   - Multi retort stocker

54. What is the use of pulveriser and name different types of pulverising mills?

The pulveriser is used to pulverise the coal in order to increase the surface exposure. Pulverised coal enables rapid combustion. The different types of pulverising mills are

1. Ball mill
2. Hammer mill
3. Ball and race mill.

55. Why ash handling system is needed?

- To remove the ashes from the furnace ash hopper
- To transport the ashes from furnace ash - hopper to a storage
- To dispose the ashes from the storage

56. Name different types of dust collectors?

1. Mechanical Dust collector
   Gravitational separators
   Bag house dust collector

There are three types of bag house dust collector

- Open pressure type
- Closed pressure type
- Closed suction type

2. Cyclone. Separators
3. Elector Static Precipitator (ESP)

57. What is the main purpose of chimney?

The main purpose of chimney is to emit the flue gases at a considerable height to avoid nuisance to the surrounding people.

58. Define forced draft and induced draft cooling towers.

If the fan is located at the bottom of the tower and air is blown by the fan up through the descending water it is called as forced draft cooling towers

If the fan is located at the top of the tower and air enters through the louvers located on the tower's side and drawn up and discharge through the fan casing, it is called as induced draft.

59. What is the working principle of Cooling Towers?

The hot water is sprayed from the top of the tower, while the air is made to flow from the bottom of the tower to the top. This air cools the hot water in the cooling tower. Air vaporises a small percentage of water, there by cooling the remaining water. The air absorbs the heat and leaves at the top of the tower and cooled water leaves at the bottom and recirculated to the condenser.

60. Name different types of cooling towers?

The cooling towers are classified as follows.

(a) According to the construction of material

1. Timber - for small tower
2. Ferro concrete - for large capacity stations.
3. Multi deck concrete towers - for large steam stations
4. Metallic

(b) According to the nature of air draught-

1. Atmospheric (or) Natural draught cooling system
2. Mechanical draught cooling tower.
1. Natural draft spray filled towers
2. Natural draft packed type towers.'
3. Hyperbolic cooling towers

61. How mechanical draft cooling towers are classified?

Mechanical draft cooling tower is classified into three types

1. Forced draft tower.
2. Induced draft counter flow tower
3. Induced draft cross flow tower.

62. How the dry type cooling towers are classified?

The dry type cooling towers are classified into two types 'as follows.

1. Indirect dry type (or) Heller cooling system
2. Direct dry type-cooling system

PART -B

1. Draw a general layout of thermal power plant and explain the working of different circuits.
2. Explain the gas turbine power plant with neat sketch.
3. Explain the nuclear power plant with neat sketch.
4. Draw and explain the layout of diesel power plant.
5. Draw the layout MHD open cycle generator and explain its function of components.
6. Sketch the layout of a hydroelectric power plant and explain the functions of each component in it. Discuss the advantages and limitations of the plant.
7. Draw a line diagram of Benson boiler and discuss its relative merits and demerits.
8. What do you understand by supercharged boiler? Explain its working with neat sketch ?
9. Explain the various types of fluidized bed boilers.
10. draw a line diagram of Fluidised bed combustion system?
11. Draw an explanatory line diagram of an ash handling system employed in steam power plants 12. Explain the difficulties encountered in the handling of ash in a thermal power station.
13. Explain the difficult types of coal handling process.
14. Explain the principle involved in preparation of coal and what are the methods of preparation?
15. What are the different types of dust collectors used.
16. What are the different types of pulverizing mills? Explain with its neat sketch.
17. How ash is handled in the power plant? Explain the ash handling system.
18. What are the methods used for pulverized fuel burning?
19. Explain the various draught systems with a neat sketch.
20. Explain the principle involved in design of chimney.
21. What are the different types of cooling towers? Explain with a neat sketch.
22. Explain the analysis of pollution from thermal power plants.
23. What are the methods used for control the pollutants.
24. Differentiate between forced draught and induced draught system in cooling tower.

UNIT II
DIESEL, GAS TURBINE AND COMBINED CYCLE POWER PLANT

PART – A

1. **What is a thermodymanic cycle?**
   Thermodymanic cycle is defined as the series of processes performed on the system, so that the system attains its original state.

2. **What are the assumptions made for air standard cycle analysis?**
   i. The working medium is a perfect gas throughout.
   ii. It follows the law PV=mRT
   iii. The working medium does not undergo any chemical change throughout cycle.
   iv. The compression and expansion processes are reversible adiabatic .There are no loss or gain of entropy.

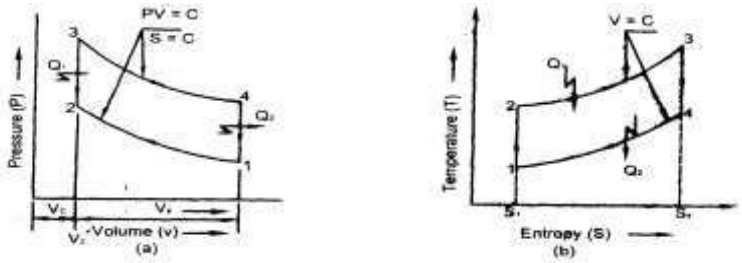
3. **Name the various gas power cycles.**
   There are many thermodymanic gas power cycles.
   i. Carnot cycle ii. Otto cycle
   iii. Diesel cycle iv.Bryton cycle
   v. Duel combustion cycle vi. Atkinson cycle.

4. **Define air standard cycle efficiency.**
   Air standard efficiency is defined as the efficiency of an engine using air as the working fluid. In other words, the thermal efficiency of the ideal air standard cycle is known as air standard efficiency. This is often called as ideal efficiency.

$$\text{Air standard efficiency} = \frac{\text{Work done}}{\text{Heat supplied}}$$

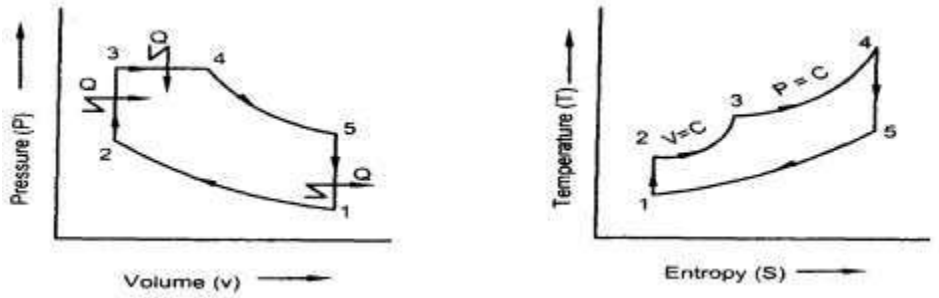
$$= \frac{(\text{Heat supplied}) - (\text{Heat rejected})}{\text{Heat supplied}}$$

5. Sketch Otto cycle on PV diagram and name all the processes.



1-2= Isentropic compression
2-3= Constant volume heat supplied
3-4= Isentropic expansion
4-1= Constant volume heat rejection

6. Sketch dual cycle on PV and TS coordinates and name the various processes.



1-2= Isentropic compression
2-3= Constant volume heat addition,
3-4= Constant pressure heat addition
4-5= Isentropic expansion
5-1= Constant volume heat rejection

7. Sketch Diesel cycle on PV diagram and name all the process.

1-2= Isentropic compression
2-3= Constant pressure heat addition,
3-4= Isentropic expansion
4-1= Constant volume heat rejection

8. Which cycle is more efficient with respect to the same compression ratio?

For the same compression ratio, Otto cycle is more efficient than diesel cycle.

9. Define mean effective pressure.

Mean effective pressure is defined as the constant pressure acting on the working stroke. It is also defined as the ratio of work done to the stroke volume or piston displacement volume.

Mean effective pressure,

$$P_{mi} = \frac{\text{Indicated power}}{\text{No. of working stroke x stroke volume per second}}$$

10. Define the following terms.(i) Compression ratio (ii) cut off ratio and (iii) Expansion ratio.

(i) Compression ratio is defined as the ratio between total cylinder volume to clearance volume.

(ii) Cut off ratio is defined as the ratio of volume after the heat addition to volume before heat addition.

(iii) Expansion ratio is the ratio of volume after the expansion to the volume before expansion.

11. What is the effect of cut off ratio on the efficiency of diesel cycle when the compression ratio is kept constant?

When cut off ratio of diesel cycle increases, the efficiency of cycle is decreased when compression ratio is kept constant and vice versa

12. Write down the expression for mean effective pressure for Otto cycle.

$$\text{Mean Effective Pressure} = \frac{P_1 r_p \left\{ \left(r_p^{\gamma-1} - 1 \right) \left(r_p - 1 \right) \right\}}{(\gamma - 1)(r - 1)}$$

13. Write down the expression for mean effective pressure for dual cycle.

$$\text{Mean Effective Pressure} = \frac{P_2 r_p \left\{ r_p^{\gamma-1} \left(r_c - 1 \right) + \gamma r_p r_c^{\gamma-1} \left(r_c - 1 \right) - \left(r_c^{\gamma} r_p - 1 \right) \right\}}{(\gamma - 1)(r - 1)}$$

14. Write down the expression for mean effective pressure for Diesel cycle.

$$\text{Mean Effective Pressure} = \frac{P_2 r_c \left\{ \gamma r_c^{\gamma-1} \left(r_c - 1 \right) - \left(r_c^{\gamma} - 1 \right) \right\}}{(\gamma - 1)(r - 1)}$$

15. Write any four major differences between Otto and Diesel cycles.

SL.NO	OTTO CYCLE	DIESEL CYCLE
1	Otto cycle consists of two isentropic and two constant volume process	It consists of two isentropic, one constant volume process and one constant pressure.
2	Heat addition takes place of constant volume	Heat addition takes place of constant pressure
3	Compression ratio is equal to the expansion ratio	Compression ratio is greater than expansion ratio
4	Efficiency is more than diesel cycle for the same compression ratio and heat input	Efficiency is less

16. Write the expression for efficiency of the diesel cycle in terms of compression ratio and cut of ratio.

$$\eta_{cy} = \left\{1 - \frac{\left[r_c^{\gamma} - 1\right]}{\gamma r^{\gamma-1}\left[r_c - 1\right]}\right\}$$

r = compression ratio

r_c= cut off ratio

17. What are all modification carried out in Brayton cycle? Why?

In Brayton we incorporate (i) Regenerator (ii) Reheater and (iii) Intercooler, because of increasing thermal efficiency of the cycle.

18. Is it always useful to have a regenerator in a gas turbine power cycle? Why?

It is not always useful to have a regenerator in a gas turbine cycle. Regenerator causes pressure drop of 0.035 to 0.2bar in compressed air and about 0.035bar in exhaust gases. These pressure drops affect to a contain extend the gain in efficiency due to regeneration.

19. What is the expression for optimum pressure ratio for maximum specific work out –put in Brayton cycle?

Optimum pressure ratio $R_p = [T_3/T_1]^{\gamma/2(\gamma-1)}$.

20. What are the effects of introducing regeneration in the basic gas turbine cycle?

(i) The fuel economy is improved. The quality of fuel required per unit mass of air is less.
(ii) The work output from turbine, work required to the compressor will not change.
(iii) Pressure drop will occur during generation.
(iv) It increases the thermal efficiency when the low pressure ratio reduces.

21. What are the effects providing the intercooler in the gas turbine cycle?

(i) Heat supply is increased.
(ii) It decreases the thermal efficiency.
(iii) Work ratio will be increased.
(iv) Specific volume of air is reduced.

22. When the reheater is employed in the gas turbine cycle.

When the air-fuel ratio is high, the combustion product after expansion in the high-pressure turbine contains more oxygen. This is done by introducing reheater. So, the exhaust pressure can be sent and expressed again in the low-pressure turbine.

23. What is the effect of reheat cycle?

(i) Thermal efficiency is less since the heat supplied is more.

(ii) Turbine output is increased for same expansion ratio.

PART - B

Otto Cycle:

1. Derive an expression for air standard efficiency of an Otto cycle. Obtain an expression for mean effective pressure of an Otto cycle.
2. In an engine working on constant volume cycle, the pressure, temperature and volume at the beginning of the cycle are 1.2 bar, 35^{o}C and 0.5 m^{3}respectively. At the end of compression stroke, the pressure is 12 bar. 315 kJ of heat is added per kg of gas during constant volume heating process. Calculate the pressure, temperature and volume at all points. Also find the air standard efficiency of the cycle.
3. A six cylinder petrol engine has a compression ratio of 5:1. The clearance volume of each cylinder is 110CC. It operates on the four stroke constant volume cycle and the indicated efficiency ratio referred to air standard efficiency is 0.56. At the speed of 2,400 rpm, it consumes 10kg of fuel per hour. The calorific value of fuel is 44,000KJ/kg. Determine the average indicated mean effective pressure.
4. An engine working on Otto cycle has a volume of 0.45m^{3}, pressure 1 bar and temperature 30^{o}C at the beginning of compression stroke. At the end of compression stroke, the pressure is 11bar and 210KJ of heat is added at constant volume. Determine (i) Pressure, temperatures and volumes at salient points in the cycle. (ii) Efficiency.
5. The compression ratio in an air-standard Otto cycle is 8. At the beginning of the compression stroke the pressure is 0.1Mpa and the temperature is 15°C. The heat transfer to the air per cycle is 1800 kJ/kg of air. Take C p and Cv for air as 1.005and 0.7 18 kJ/kg K respectively. Determine the following (i) The pressure and temperature at the end of each process of the cycle. (ii) The thermal efficiency. (iii) The mean effective pressure.
6. An engine 20 cm bore and 30 cm stroke works on Otto cycle. The clearance volume is 1600 cu cm. The initial pressure and temperature are 1bar and 60°C. If the maximum pressure is limited to 24 bar, find the following :(i) The air standard efficiency (ii) The mean effective pressure of the cycle.
7. An engine working on Otto cycle has a volume of 0.45 m^{3}, pressure 1 bar and temperature 30^{o}C at the beginning of compression stroke. At the end of compression stroke, the pressure is 11 bars. 210 kJ of heat added is at constant volume. Determine (i) Pressures, temperatures and volumes at salient point in the cycle,(ii) Percentage of clearance(iii) Efficiency(iv) Mean effective pressure(v) Ideal power developed by the engine if the number of working cycle per minute is 210.
8. In an air standard Otto cycle the compression ratio is 6.5, and at the beginning of isentropic compression, the temperature is 15^{o}C and the pressure is 1 bar. Heat is added during constant volume process so that the maximum temperature in the cycle is 1480ºC. Calculate (i) The heat supplied per kg of air, (ii) The cycle efficiency and (iii) The mean effective pressure.

Diesel Cycle:

1. Derive an expression for mean effective pressure of a Diesel cycle in terms of pressure ratio, cutoff ratio and compression ratio.

2. 1kg of air is taken through a diesel cycle. Initially the air is at 25^{o}C and 1 bar. The compression ratio is 14 and the heat added is 1850KJ. Calculate the ideal cycle efficiency and the mean effective pressure.
3. Draw the theoretical and actual P.V. diagrams for 4-stroke diesel engine and explain why in practice the actual condition differs from the ideal condition.
4. In an air standard Diesel cycle, the compression ratio is 18, and at the beginning of isentropic compression, the temperature is 27ºC and the pressure is 0.1 MPa.1800 kJ of heat is added at constant pressure. Calculate i) the cut-off ratio, ii) the heat supplied per kg of air iii) the cycle efficiency and iv) mean effective pressure
5. An engine with 200 mm cylinder diameter and 300 mm stroke works on theoretical diesel cycle. The initial pressure and temperature of air used are 1bar and 27^{0}C. The cut-off ratio is 8% of the stroke. Determine (i) pressures and temperatures at all the salient points (ii) theoretical air standard efficiency. Assume that compression ratio is 15 and working fluid is air. Consider all conditions to be ideal.

Dual Cycle:

1. With the help of p-v and T-s diagrams, show that for the same maximum pressure and temperature of the cycle and the same heat rejection ηDiesel>ηDuaI<ηOtto
2. In a dual cycle the air is compressed isentropically to 1/14thof its initial volume. At the end of compression heat is added at constant volume till its pressure increases to twice the pressure at the end of compression. Then heat is added at constant pressure till its volume increases to twice the volume after compression. Find the efficiency of the cycle.
3. In engine working on Dual cycle, the temperature and pressure at the beginning of cycle are 90^{o}C and one bar. The compression ratio is 9. The maximum pressure is limited to 68bar and total heat supplied per kg of air is 1750kJ. Determine air standard efficiency and mean effective pressure.
4. A dual combustion air standard cycle has a compression ratio of 10. The constant pressure part of combustion takes place at 40 bar. The highest and the lowest temperatures of the cycle are 1727° C and 27° C respectively. The pressure at the beginning of compression is 1 bar. Calculate (i) The pressures and temperatures at key points of the cycle, (ii) The heat supplied at constant volume, (iii) The heat supplied at constant pressure, (iv) The heat rejected, (v) The work output, (vi) The efficiency and (vii) MEP.
5. An air standard dual cycle has a compression ratio of 16 and compression begins at1.013 bar, 50°C. The maximum pressure is 70 bar. The heat transferred to air at constant pressure is equal to that at constant volume. Estimate the temperatures at the cardinal points of the cycle and the cycle efficiency.
6. An air-standard Dual cycle has a compression ratio of 10. The pressure and temperature at the beginning of compression are I bar and 27°C. The maximum pressure reached is 42 bar and the maximum temperature us 1500^{o}CDetermine(i)The temperature at the end of constant volume heat addition(ii)Cut-off ratio(iii)Work done per kg of air and(iv)Network output per kg(v)Cycle efficiency.

Brayton Cycle:

1. Derive an expression for air standard efficiency of a Brayton cycle in terms of pressure ratio and compression ratio. Also prove that the pressure ratio for maximum work is a function of limiting temperature ratio.
2. The extreme of pressure and temperature in an open circuit constant pressure gas turbine plant are 1 bar, 5.25bar and 25^{o}C and 560^{o}C respectively. The isentropic efficiency of the turbine is 88% and that of the compressor is 84%.Determine the efficiency of the plant.
3. A gas turbine works on an air standard Brayton cycle. The initial condition of the air is 25°C and 1 bar. The maximum pressure and temperature are limited to 3 bar and 650°C. Determine the following:(i) Cycle efficiency (ii) Heat supplied and heat rejected/kg of air (iii) Work output/kg of air (iv) Exhaust temperature.

4. An air standard Limited pressure cycle has a compression ratio of 15 and compression begins at 0.1MPa, 40°C. The maximum pressure is limited to 6MPa and the heat added is 1.675 MJ/Kg. Compute (i) The heat supplied at constant volume per kg of air, and the heat supplied at constant pressure per kg of air. (ii)The work done per kg of air, the cycle efficiency, and the temperature at the end of the constant volume heating process.iii) The cut-off ratio, and iv) The m.e.p. of the cycle.

UNIT III
NUCLEAR POWER PLANTS
PART - A

1. Write about atomic number?

The nucleus contains protons and neutrons. The number of protons in a given atom is an atomic number (Z). The atomic number for H is 1 and He -is 2.

2. Write about isotopes of an element?

Some elements have the same number of protons in the nucleus but different number- of neutrons. As a result, these elements have the same atomic number but different mass number. Such type of elements which ' have the same atomic number – same number of protons - the -same chemical properties but different mass numbers due to different number of neutrons, are known as I the isotopes of an element.

3. What are the requirements to sustain fission process?

- The bombarded neutrons must have sufficient energy to cause fission
- The number of neutrons produced must be able to create the rate of fission
- The fission process must generate energy
- The fission process must be controlled

4. Define multiplication factor of a fission process.

$$k = \frac{\text{Number of neutrons of any one generation}}{\text{Number of neutrons of immediately preceding generation.}}$$

5. Define fertile materials and breeding in reactors

There are materials like U235 and Th^{232} which are not fissile but can be converted into fissile materials by the bombardment of neutrons. Such materials are known as fertile materials.

The process of converting more fertile material into fissile material in a reaction is known as breeding.

6. Name few types of reactors.

Fast reactors, Thermal reactors, natural fuel reactors, Enriched Uranium reactors, water moderated reactors, heavy water moderated reactor, graphite moderated reactor, gas cooled reactors and Sodium cooled reactors.

7. What are the advantages of breeder reactors?

- It gives high power density than any other reactor
- High breeding is possible
- High burn-up of fuel is achievable
- The operation of the reactor is not limited by Xe poisoning

8. What are the demerits of breeder reactor?

- Highly enriched fuel is required
- Control is difficult and expensive
- Safety must be provided against melt down
- Handling of sodium is a major problem

9. What is the purpose of control rods?

The control rods are used to start the chain reaction, maintain the chain reaction at required level and to shut down the reactor during emergency.

10. What is meant by Nuclear fission?

Uranium exists in different isotopes of U238, tP34 and U235. Out of these, EP35 is most unstable. When unstable heavy nucleus is bombarded with high-energy neutrons, it splits up roughly into two equal fragments and about 2.5 neutrons are released and a large amount of energy is produced. This process is called nuclear fission.

11. Name the different components of nuclear reactor?

1. Nuclear fuel 2. Moderator 3. Control rods 4. Reflectors
5. Reactor vessel 6. Biological shielding 7. Coolant

12. State some advantages of Pressurized Water reactor?

- The pressurized water reactor is compact
- In this type, water is used as coolant, moderator and reflector water is cheap and available in plenty)
- It requires less number of control rods.

13. What are the advantages of gas cooled reactor nuclear power plant?

1. Fuel processing is simple
2. The use of C02 as coolant completely eliminates the possibility of explosion in reactor.
3. No corrosion problem

14. What is breeding in nuclear reactor?

The process of producing fissionable material from a fertile material such as uranium 238 (U238) and thorium 232 (Th232) by neutron absorption is known as breeding.

15. Name the coolants commonly used for fast breeder reactors?

Liquid metal (Na (or) Na K)
Helium (He)
Carbon dioxide.

16. Define Nuclear Fusion.

Fusion means joining smaller nuclei to make a larger nucleus. The sun uses nuclear fusion of hydrogen atoms into helium atoms . This gives off heat and other radiation.

17. List the various widespread power plant reactor types.

1. Pressurized water reactor(PWR)
2. Boling water reactor(BWR)
3. Pressurized Heavy water reactor(PHWR)
4. Liquid metal fast Breeder Reactors(LMFBR)
5. High temperature Gas cooled reactors(HTGCR)

18. What is pressurized water reactor (PWR)?

The PWR belongs to the lidht water type. The moderator and the coolant are both light water(H2O). The cooling water circulates in two loops, which are fully separated from one another. PWR keep water under pressure, so the water heats but does not boil even at the high operating temperature.

19. What is boiling water reactor (BWR)?

In a boiling water reactor, Light water plays the role of moderator and coolant as well. Part of the water boils away in the reactor pressure vessel, thus a mixture of water and steam leaves the reactor core.

20. Nuclear Power plant safety.

Radiation doses can be controlled through the following procedures:

1.The handling of equipment via remote in the core of the reactor
2. Physical shielding
3. Limit on the time a worker spends in areas with significant radiation levels
4. Monitoring of individual doses and of the working environment
5. Safety mechanism of a Nuclear power reactor

21. List the factors to be considered for the selection of site for hydro power plant.

1. Availability of water and water head
2. Accessibility of site
3. Water storage capacity
4. Distance from the load center
5. Type of land

22. List the classification of dams:

1. Based on their functions:
   (a) storage dams
   (b) Diversion dams
   (c) Detention dams
2. Based on their shape:
   (a) Trapezoidal dams
   (b) Arch dams
3. Based on the materials of construction:
   (a)Earth dams
   (b) Rock pieces dams
   (c) Stone masonary dams
   (d) concrete dams
   (e) RCC dams (f)Timber and Rubber dams

4. Based on hydraulic design:
    (a) Overflow type dam
    (b) Non-overflow type dam
5. Based on structural Design:
    (a) Gravity dam
    (b) Arch dam
    (c) Buttresses dam

23. What is a surge tank?

A surge tank is a small reservoir in which the water level rises or falls to reduce the pressure swings during opening and closing of inlet valve. The surge tank is not required for run off plants and medium head plants.

24. What is a Draft tube?

The draft tube allows the turbine to be set above the tail race to facilitate inspection and maintenance. It also regains the major portion of the kinetic energy at the runner outlet by diffuser action. The draft tube can be a straight conical tube or an allow tube.

25. List the equipments present in a power house:

1. Hydraulic turbines
2. Electric generators
3. Governors
4. Gate valves and rehet valves
5. Water circulating pumps
6. Air duct
7. Switch board and instruments

26. List the advantages of impulse turbine:

1.Greater tolerance of sand and other particles in the water
2.Better access to working parts
3.No pressure seals around the shaft
4.Easier to fabricate and maintain

27.Explain Reservoir:

A reservoir may be natural, like a lake on a mountain or artificially built by erecting a dam across a river.

28. Define surge tank:

A Surge tank is a small reservoir in which the water level rises swings during opening and closing of inlet valve.

29. What is mini Hydro plants?

The mini power plants operate with 5m-20m head and produce about 1 MW to 5 MW of power.

30. Define turbines:

A turbine converts energy in the form of falling water into rotating shaft power. The selection of best turbine for any particular site depends on the site characteristics.

31. What is pelton turbine?

A pelton turbine consists of a set of specially spread buckets mounted on a periphery of a circular disc. It is turned by jets of water which are discharged from one or more nozzles.

32. What is meant by reaction turbines?

Francis turbine and propeller turbines are the reaction turbines. The reaction turbines rotate faster than impulse turbine.

33. What is meant by Kaplan turbine?

The pitch of the propeller blades together with wicket gate adjustment, enables reasonable efficiency to be maintained under part flow conditions. Such turbines are called as Kaplan turbines.

PART – B

1. What is chain reaction? How it is maintained? What is the difference between controlled and uncontrolled chain reaction? Explain with neat sketches and with examples.
2 .Describes the boiling water reactor with the help of neat sketch and explain its chief characteristics. Discuss the salient features of the nuclear waste disposal.
3. What is a chain reaction? How it is controlled? Explain with a neat sketch a boiling water reactor.
4. Explain the working of a typical fast breeder nuclear reactor power plant, with the help of neat diagram .Write short notes on Nuclear waste disposal .
5. What are the difference between a pressurized water reactor nuclear power plant and boiling water reactor nuclear power plant?
6. What are the advantages and disadvantages of nuclear power plant?
7. Differentiate pelton wheel turbine with Francis turbine.
8. Draw a layout of a typical micro hydro scheme and explain its working in detail.
9. Explain the construction and working of candu reactor?
10. Explain with neat sketch the indirect gas cooled reactor?
11. Explain with neat sketch of hydro electric power plant?

UNIT IV
POWER FROM RENEWABLE ENERGY
PART – A

1. List the advantages of gas turbine power plant.

1. Low capital cost
2. High reliability
3. Flexibility in operation
4. Capability to quick start
5. High efficiency e.t.c.

2. List the major components of gas turbine.

1.Compressor
2. Combustion chamber and
3. Turbine

3. List the types of gas turbine power plants.

1.Open cycle gas turbine power plant
2. Closed cycle gas turbine power plant

4. List the disadvantages of gas turbine power plant.

1.No load and Partial load efficiency is low
2.High sensitive to component efficiency
3. The efficiency depends on ambient pressure and ambient temperature
4. High air rate is required to limit the maximum inlet air temperature. Hence exhaust losses are high
5. Air and gas filter is required to prevent dust into the combustion chambers.

5. Define regenerator efficiency.

The regenerator efficiency is defined as:
=Actual temperature rise of air/ Maximum temperature rise possible

6. List the factors which affect the performance of gas turbine power plants.

1. Part load efficiency
2. Fuel consumption
3. Air mass flow rate
4. Thermal efficiency
5. Regeneration

7. What are the working fluids in gas turbine?

1.Air
2.Helium
3.Argon
4.Carbon dioxide

8. List the various types of diesel plants.

Based on number of strokes:

(a) Two stroke diesel engine
(b) Four srtoke diesel engine

Based on orientation:

(a) Horizontal diesel engine
(b) Vertical diesel engine

Based on number of cylinders:

(a) single cylinder
(b) Multi cylinder

And other type like naturally aspirated, superheated etc.,

9. List the components of diesel power plant.

1.Diesel engine
2. Air intake system
3. Exhaust system
4. Fuel system
5. Cooling system
6. Lubricating system
7. Starting of engine

10. List the classification of oil injection system.

(a) Common rail injection system
(b) Individual pump injection system
(c) Distributor system

11. List the reason why the cooling system is necessary for a diesel engine.

1. To avoid detemiation of lubricating oil
2. To avoid damages and overheating of piston
3. To avoid uneven expansion which results in craking
4. To avoid pre-ignition and detonation or knocking
5. To avoid reduction in volumetric efficiency and power output of the engine

12. What are the methods of cooling system used?

1. Air cooling
2. Water cooling

13. List the various types of lubricating system used in diesel engine.

1. Mist lubricating system
2. Wet sump lubrication system
3. Dry sump lubrication system

14. What are the starting methods of diesel engine?

1. By an auxiliary engine
2. By an electric motor
3. By compressed air

15. List any four advantages of diesel power plant.

1. It is easy to design and install
2. It is easily available in standard capacities
3. They can respond to load changes
4. They have less stand by losses

16. List any four disadvantages of diesel power plant.

1.High operating cost
2.High maintenance and lubrication cost
3.Capacity is restricted

17. List any four applications of diesel power plant.

1. Used as peak load plants
2. Suitable for mobile plants
3. Used as standby units
4. Used as emergency plant

PART - B

1. Draw and explain the layout of a modern diesel power plant showing the following systems.
   a. Air Intake system
   b. Cooling system
   c. Fuel supply system
   d. Lubrication system and
   e. Exhaust system.
2. Describe the auxiliary equipment's of a diesel engine power plant. what are the disadvantages of this plant
3. Explain the various types of cooling system used in diesel power plant ?
4. Give the layout of diesel engine power plant. What are the advantages and disadvantages of diesel power plants?
5. Derive an expression for air standard efficiency of Brayton cycle interms of (i) compression ratio and (ii) the pressure ratio.
6. Why is the Brayton cycle most suitable for gas turbine power?
7. Bring out the difference between the closed cycle and open cycle gas turbine power plants ?
8. Draw a neat diagram of a regenerative gas turbine and reheater and also explain it working with a help of a p-v diagram.
9. Explain with neat sketch of open and closed cycle gas turbine power plant?
10. Sketch the Brayton cycle. Air enters the compressor of the cycle at at 1 bar and 250c. Pressure after compression is 3 bar. Temperature at turbine inlet is 6500c. Determine per kg of air the (i) cycle efficiency (ii) heat supplied to air,(iii) work available (iv) heat rejected in the cooler and (v) Temperature of air leaving the turbine.
11. With PV and TS diagram explain the effect of intercooling, reheating and regeneration in a gas turbine plant

12. Discuss the materials which are used for gas turbine and compressors. What properties should the blade materials posses?
13. A gas turbine working on theoretical air cycle draws air initially at 250c and 1 bar. The maximum pressure andtemperature is 3 bar and 6500c. Calculate air standard efficiency, heat supplied, heat rejected, work output per kg of air exhaust temperature.
14. In an air standard Brayton cycle, the air enters the compressor at 1 bar and 150c. The pressure leaving the compressor is 5bar, the maximum temperature in the cycle 9000c .find the following
a. Compressor and expander work per kg of air
b. The cycle efficiency. If an ideal regenerator is incorporated into the cycle, determine the % change in efficiency .
15. Consider a stationary power plant operating on an ideal Brayton cycle. The pressure ratio of the cycle is 8 and the gas temperature at the compressor inlet and turbine inlet are 270c & 10270c respectively. Determine the following :
a. Gas temperature at the compressor and turbine exit
b. Back work ratio and
c. Thermal efficiency.
Assume pr1 = 1.386 and pr3 = 330.9. Where, pr is the relative pressure.

UNIT V
ENERGY, ECONOMIC & ENVIRONMENTAL ISSUES OF POWER PLANTS
PART - A

1. List the classification of OTEC based on location.

1. Land based plant
2. Shelf based plant
3. Floating plant

2. List the classification of OTEC based on cycle.

1. Open cycle
2. Closed cycle
3. Hybrid cycle

3. List any four benefits of OTEC.

1. Airconditioning
2. Chilled soil agriculture
3. Aquaculture
4. Desalination

4. List any four disadvantages of OTEC.

1. Degradation of heat exchanger performance as dissolved gases.
2. Degradation of heat exchanger performance by microbial fouling
3. Improper sealing
4. Parasitic power consumption by exhaust compressor

5. What are the various ways of creating tidal energy?

1. TidalBarrager
2. Tidal fences
3. Tidal turbines

6. List the various types of turbines used in tidal power station.

1. Buld turbine
2. Rim turbine
3. Tubular turbines

7. What are the components of tidal power station?

1. Barrage
2. Turbines
3. Sluices
4. Embankments

8. List any four advantages of tidal power generation.

1. Renewable and sustainable energy
2. No liquid or Solid pollution
3. Little visual impact
4. Reduces dependence upon fossil fuels

9. List the limitations of tidal energy.

1. Orientation problem
2. Requires storage devices
3. Available at a lower rating and time
4. High capital cost

10. What are the main parts of geothermal power plant?

1. Production well
2. Vaporizer
3. Circulating pump
4. Expansion turbine
5. Generator
6. Condenser
7. Transformer

11. What are the classifications of geothermal energy conversion system?

1. Single cycle geothermal power plant
2. Binary cycle power plant

12. What are the applications of geothermal energy?

1. Generation of electric power
2. Space heating for building
3. Industrial process heat

13. What are the advantages of geothermal energy?

1. Cheaper
2. Versatile in its use
3. Delivers greater amount of energy

14. What are the disadvantages of geothermal energy?

1. Drilling operation is noisy
2. It needs large areas of exploitation of geothermal energy
3. Low overall power production efficiency.

15. What are the characteristics of solar central receiver system?

a) All parts of it use known technologies.

b) Boiler or absorber is a light absorber and low volume unit, resulting in low heat losses from it.

16. Define load curve?

It is a graphical representation which shows the power demands for every instant during a certain time period.

17. Define depreciation.

It is the amount to be set aside per year from income to meet the depreciation caused by the age of service, wear tear of machinery.

PART - B

1. Explain the different types of geothermal energy sources.
2. Find the cost of generation per kW-hr from the following data.
Capacity of the plant - 120MW
Capital cost - Rs.1,200 per kW installed
Interest and depreciation - 10 %on capital
Fuel consumption - 1.2 kg / kW-hr.
Fuel cost - Rs. 40 tone
Salaries, wages, repairs and maintenance - 6, 00,000 / year
The maximum demand is 80 MW and load factor is 40 %.
3. A central power station has annual factors as follows:
Load factor = 60%
Capacity factor = 40%
Use factor = 45%
Power station has a maximum demand of 15,000kW.Determine; Annual energy production, Reserve capacity
over and above peak load, Hours per year not in service.
4. A power station has two 60MW units each running for 1500hours a year. The energy produced per year is 700 x 106 kW-hr. Calculate the plant load factor and plant use factor.
5. Sketch and explain the two pool tidal power plant
6. Describe with help of neat sketch the working of a solar thermal receiver system plant and enumerate the advantages and disadvantages of concentrating collectors over flat plate collectors.
7. Discuss the different system used for generating power using geothermal energy.
8. What do you understand by power plant economics? Explain the fixed costs and operating costs of a power station.
9. What is meant by load factor and diversity factor?
10. Explain working of hybrid OTEC system and what are the advantages?
11. Enumerate and explain the various types of prime movers used in geothermal energy conversion systems.