MAHARASHTRA STATE BOARD OF TECHNICAL EDUCATION
(Autonomous)
(ISO/IEC - 27001 - 2013 Certified)

WINTER – 2022 EXAMINATION

Model Answer

Subject Name: Power Plant Engineering **Subject Code:** 22566

Important Instructions to examiners:

1) The answers should be examined by key words and not as word-to-word as given in the model answer scheme.
2) The model answer and the answer written by candidate may vary but the examiner may try to assess the understanding level of the candidate.
3) The language errors such as grammatical, spelling errors should not be given more Importance (Not applicable for subject English and Communication Skills.
4) While assessing figures, examiner may give credit for principal components indicated in the figure. The figures drawn by candidate and model answer may vary. The examiner may give credit for any equivalent figure drawn.
5) Credits may be given step wise for numerical problems. In some cases, the assumed constant values may vary and there may be some difference in the candidate's answers and model answer.
6) In case of some questions credit may be given by judgement on part of examiner of relevant answer based on candidate's understanding.
7) For programming language papers, credit may be given to any other program based on equivalent concept.
8) As per the policy decision of Maharashtra State Government, teaching in English/Marathi and Bilingual (English + Marathi) medium is introduced at first year of AICTE diploma Programme from academic year 2021-2022. Hence if the students in first year (first and second semesters) write answers in Marathi or bilingual language (English +Marathi), the Examiner shall consider the same and assess the answer based on matching of concepts with model answer.

Q. No.	Sub Q. N.	Answer	Marking Scheme
1	a	**Components of Diesel power plant** 1. Diesel engine 2. Generator 3. Air intake system 4. Exhaust system 5. Cooling water system 6. Fuel supply system 7. Lubrication system 8. Diesel engine starting system 9. Governing system	02 Marks (½ M for each component)
	b	**Principle of Fluidized Bed Combustion Boiler** In Fluidized Bed Combustion Boiler Technology When air or gas is passed through an inert bed of solid particles such as sand supported on a fine mesh or grid, the air initially will seek a path of least resistance and pass upward through the sand. With further increase in the velocity, the air bubbles through the bed and the particles attain a state of high turbulence. Under such conditions, the bed assumes the appearance of a fluid and exhibits the properties associated with a fluid and hence the name "Fluidized Bed combustion".	02 Marks

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Q. No.	Sub Q. N.	Answer	Marking Scheme
01	c	Fuel Handling System 1.Belt conveyor 2.Screw conveyor 3.Bucket conveyor 4.Grab Bucket conveyor 5.Skip Hoist 6.Flight conveyor	02 Marks (1M for 1 point)
	d	Waste Heat Recovery can be defined as ,"the process of collecting the heat created as an undesired byproduct of a process or operation of an equipment or machinery, so that it can be used fulfill energy requirements of some other processes." OR Waste Heat Recovery can be defined as, "the process of heat recovering from streams having high energy contain such as hot flue gases from power plants are waste water from different cooling processes such as steel cooling"	02 Marks
	e	Objectives of International Atomic Energy Agency 1. To assist members states in context of social and economic goals in planning and using nuclear science technology. 2. To develop nuclear safety standards. 3. To verify through its inspection system that states comply with their commitments. 4. To encourage and assist research and development. 5. To provide material, services, equipment and facilities of atomic energy. 6. To exchange scientific and technical information.	02 Marks (1M for 1 objective)
	f	Load Factor It is defined as the ratio of average load to the peak or maximum load determined by the consumer. Load Factor, F= Average Load/ peak or maximum load OR Load Factor, F= Total energy consumption in 24 Hours/ Max demand x 24	02 Marks

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Q. No.	Sub Q. N.	Answer	Marking Scheme
	g.	Classification of Hydro electric Power Plant 1. According to the availability of head • High head power plants • Medium head power plants • Low head power plants 2. According to the nature of load • Base load plants • Peak load plants 3. According to quantity of water available • Run-off river power plants without pondage. • Run-off river power plants with pondage • Reservoir power plants. • Pump storage plants 4. According to capacity • Mini Hydro electric Power Plant • Micro Hydro electric Power Plant	02 Marks (1M for 1 point)
2.	A	World and National scenario of demand and supply of energy: World energy consumption is the total energy produced and used by the entire human civilization. Typically measured per year, it involves all energy harnessed from every energy source applied towards humanity's endeavors across every single industrial and technological sector, across every country. It does not include energy from food, and the extent to which direct biomass burning has been accounted for is poorly documented. Being the power source metric of civilization, world energy consumption has deep implications for humanity's socio-economic-political sphere. World total primary energy consumption by fuel in 2018 Coal (27%) Natural Gas (24%) Hydro (renewables) (7%) Nuclear (4%)	02 Marks

Oil (34%)

Others (renewables) (4%)

Demand of energy in India

During the fiscal year 2017-18, the utility energy availability was 1,205 billion KWh, a short fall relative to requirements of 8 billion KWh (-0.7%). Peak load met was 160,752 MW, 3,314 MW (-2%) below requirements. In the 2018 Load Generation Balance report, India's Central Electricity Authority anticipated energy surplus and peak surplus to be 4.6% and 2.5%, respectively, for the 2018–19 fiscal year It stated that power would be made available to the few states expected to face shortages from regions with a surplus, through regional transmission links From calendar year 2015 onwards, power generation in India has been less of a problem than power distribution.

02 Marks

Supply

India has recorded rapid growth in electricity generation since 1985, increasing from 179 TW-hr in 1985 to 1,057 TW-hr in 2012.The majority of the increase came from coal-fired plants and non-conventional renewable energy sources (RES), with the contribution from natural gas, oil, and hydro plants decreasing in 2012-2017. The gross utility electricity generation (excluding imports from Bhutan) was 1,372 billion kWh in 2018-19, representing 5.53% annual growth compared to 2017-2018.The contribution from renewable energy sources was nearly 17% of the total. In the year 2018-19, more than 50% is contributed by the renewable energy sources to the total incremental electricity generation.

B

Differentiate between Velox and Loeffler boiler

Sr. No.	Velox Boiler	Loeffler Boiler
1.	Heat Transfer rate is more	Heat transfer rate is low as compare to velox boiler
2.	Evaporation of water inside the tubes.	Evaporation of water by means of super heated steam
3.	Compact Structure	Large structure
4.	High combustion rate	Less combustion rate
5.	Quick to start	Take time to start
6.	Flue gases before exhaust runs small gas turbines	Flue gases are directly exhausted ro atmosphere

04 Marks

(1M for 1 point)

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Q. No.	Sub Q. N.	Answer	Marking Scheme
	C	Steam Power Plant Advantages over Gas Power Plant. 1. Steam Power Plant quickly respond to change in loads. 2. A portion of steam generated may be used in different industries. 3. Steam Power Plant can be located near the load centre hence transmission cost reduced. 4. Steam Power Plant continuously run under overload of 25%. 5. Cheaper fuel can be used. 6. Higher thermal efficiency. 7. Steam can be condensed and reuse again, gas can not (Steam Power Plant Dis- Advantages over Gas Power Plant. 1. The design & layout of Steam Power Plant is complex than Gas Power Plant. 2. Size of Steam Power Plant is much more than Gas Power Plant. 3. The maintenance of the plant is difficult & maintenance cost is more than Gas Power Plant. 4. Steam power plant requires more water than Gas Power Plant due to condenser is used in steam power plant. 5. For coal handling and ash disposal, more maintenance and space are needed for Steam Power Plant.)	04 Marks (02 Marks) (02 Marks)
	D	**Need of Cogeneration** • Cogeneration power plants does maximum utilization of primary fuels • Cogeneration satisfies the need of electricity and process heat simultaneously • Instead of using two separate units for generation of heat and power uses a single cogeneration plant	02 Marks

		Example: Thermal power plant **Need of Cogeneration -** 1) In a conventional power plant, the fuel is burnt in a boiler, which in turn produces high pressure steam. This high pressure steam is used to drive a turbine, which is connected to an alternator and hence drive an alternator to produce electric energy. The exhaust steam is then sent to the condenser, where it gets cool down and gets converted to water and hence return back to boiler for producing more electrical energy. The efficiency of this conventional power plant is 35 % only. 2) In cogeneration plant the low pressure steam coming from turbine is not condense to form water, instead of it its used for heating or cooling in building and factories, as this low pressure steam from turbine has high thermal energy. The cogeneration plant has high efficiency of around 80 – 90%. In other words Cogeneration is a very efficient technology to generate electricity and heat. It is also called Combined Heat and Power (CHP) as cogeneration produces heat and electricity simultaneously. So cogeneration is needed - 1) To improve the efficiency of the plant. 2) To reduces cost of production and improve productivity. 3) To save water consumption and water costs. 4) To make power plant more economical as compared to conventional power plant. 5) To make fuel utilization more efficient and optimized and hence more economical. 6) To reduce air emissions of particulate matter, nitrous oxides, sulphur dioxide, mercury and carbon dioxide which would otherwise leads to greenhouse effect. 7) To reduce import dependency of fuel by increasing efficiency of p	02 Marks

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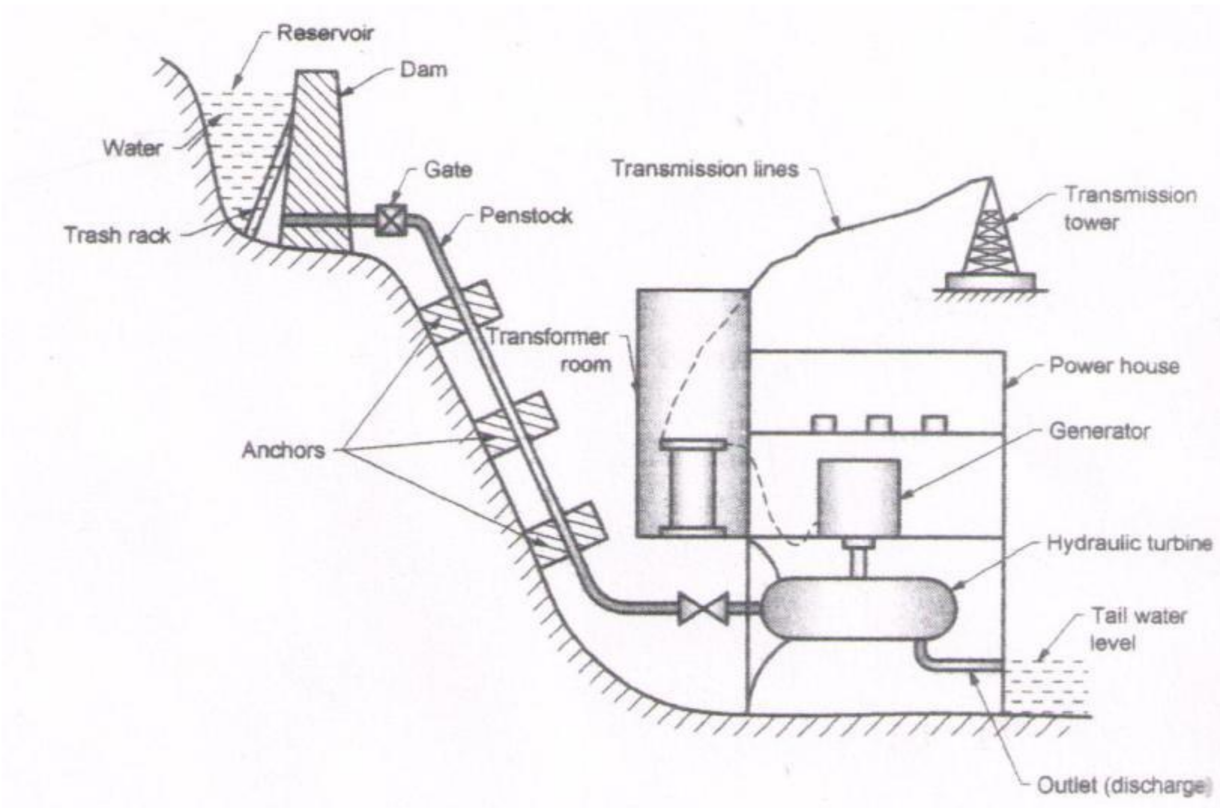
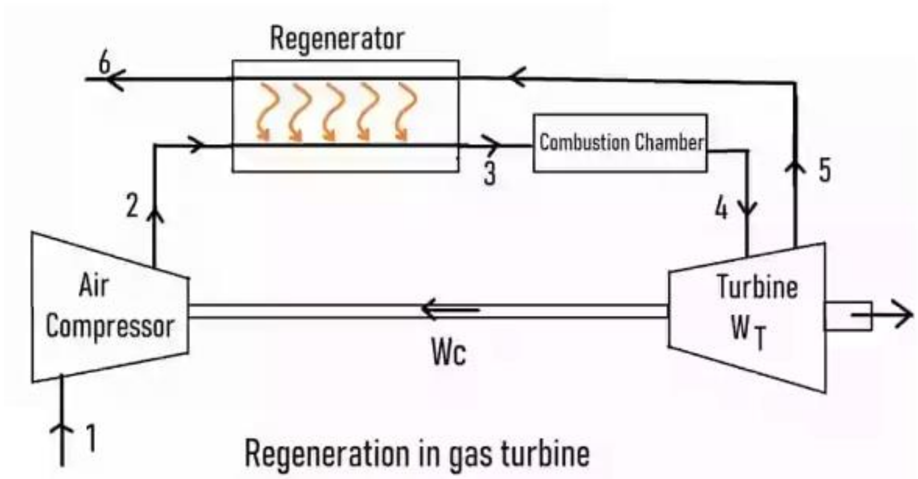
3	a		04 Marks
	B	**List of methods to improve thermal efficiency of open cycle gas turbine power plant** 1. Gas turbine with regenerator 2. Gas turbine with intercooling 3. Gas turbine plant with reheating 4. Increase compression ratio 5. Using cogeneration systems	02 Marks

Explanation :
Gas turbine plant with regenerator

02 Marks



Regeneration in gas turbine

The temperature at the exhaust of gas turbine is higher than the temperature of air at the exit of the compressor. Heat energy at the exit of the gas turbine may be used in a heat exchanger to increase the temperature of air entering the combustion chamber this will decrease the quantity of fuel used.

c

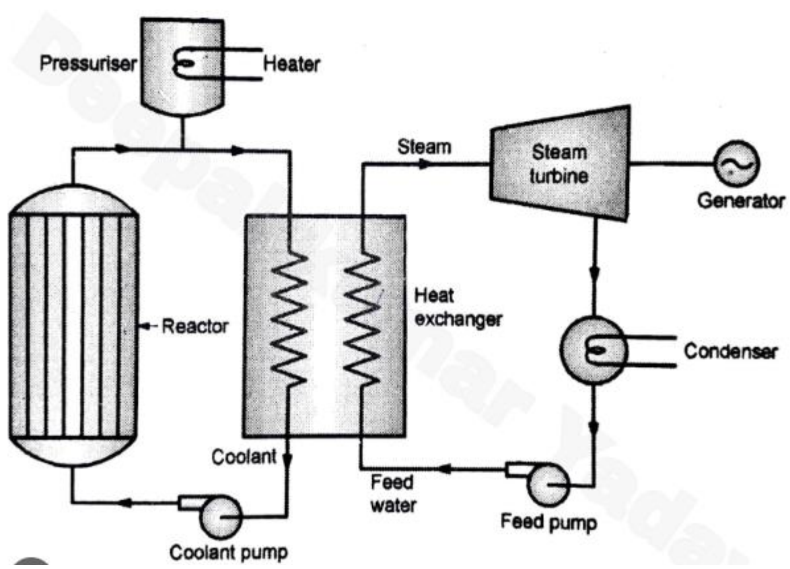
standard practices of waste heat recovery in thermal power plant

04 Marks

(1M for 1 point)

1. use of economizer
2. use of air preheater
3. use of steam super heater
4. waste heat boilers
5. regenerators
6. use of regenerative burners
7. Run around coils

d **Construction of pressurized heavy water reactor**



02 Marks

Construction
main parts are
1 Reactor

- contains the fuel tubes using natural uranium as fuel
- heat exchangers
- circulating pumps are housed in the reactor known as calendria .
- The heavy water moderator is separate from the coolant i.e. ordinary water
- control rods penetrate Calendria vertically.
- The coolant moves at a pressure nearly 10 MPa

02 Marks

2 Secondary circuit

- Contains steam collectors.
- LP and HP turbines
- generator
- condenser
- Feed pump etc. for generating steam and producing electricity by steam turbine

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Q. No.	Sub Q. N.	Answer	Marking Scheme
4	a	**Maintenance procedure of DG set** 1 Maintenance of lubrication system • Check level of lubricating oil by dipstick • Oil and oil filters should be replaced at proper time 2 Maintenance of cooling system • Keep the coolent level about ¾ • use good quality coolant mixture of water, antifreeze and additives • keep the radiator clean 3 Maintenance of fuel system • check and replaced fuel filters at required time • use the fuel before it degrades • check for fuel leaks and replace worn out parts 4 Maintenance of starting system • keep the battery fully charged and electrolyte must be filled up to the filler neck by distilled water • check the electrode connections keep them clean • start the engine and check the oil pressure 5 Exhaust system maintenance • check the connection points • gaskets welding joints coupling joint for any leakage if necessary repair the parts	04 Marks (1M for 1 point)
	b	**Safety practices in nuclear power plants** • Implementation of radiation protection and contamination control procedures • Use of proper protective equipment's • use of approved operating procedures • implementation of radiation protection training and qualification programs • use of approved maintenance procedure • conduct of refresher courses to import ALARA (as low as reasonably achievable) concept and awareness	04 Marks (1M for 1 point)

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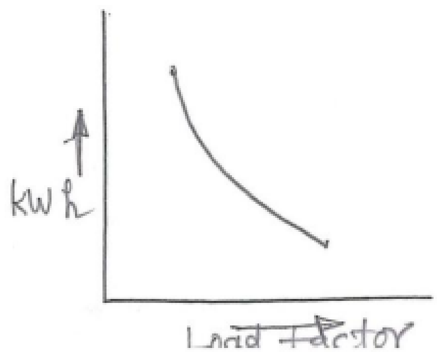
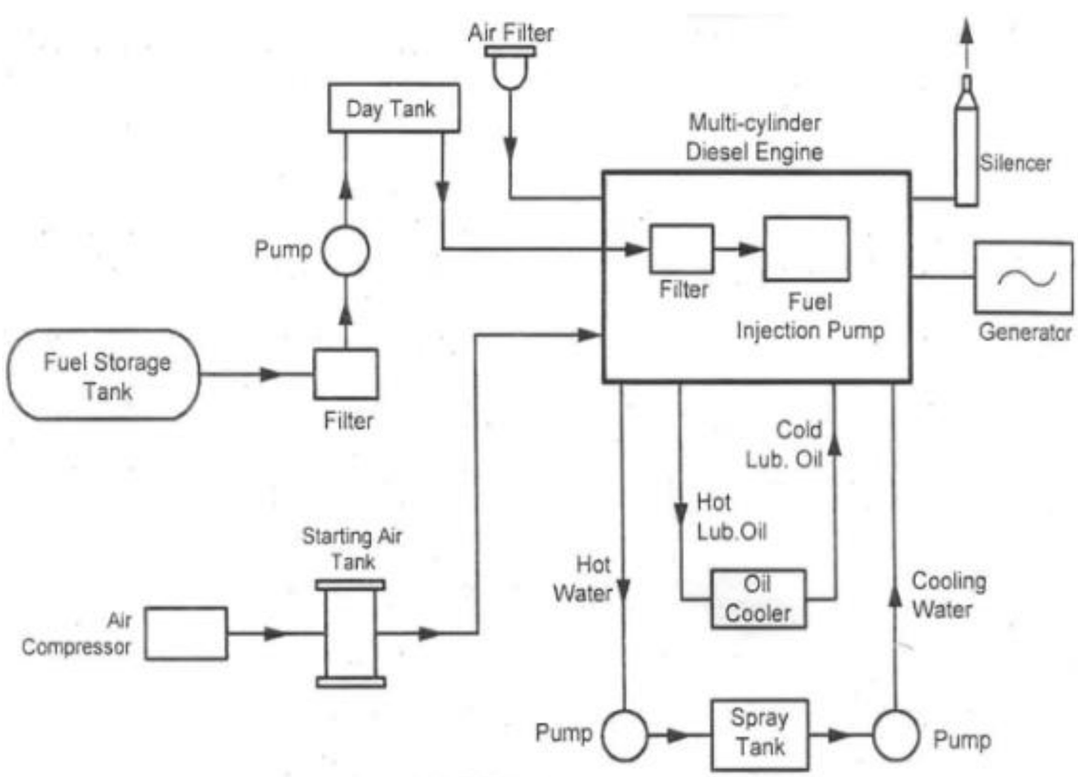
4	c	**Effect of load factor on cost of energy** The higher the load factor of the power station the lesser will be the cost per unit generated because the higher load factor means lesser maximum demand Load Factor = average load / maximum demand  	04 Marks (02 M for explanation) (02M for figure)
	d	**Layout of diesel power plant**  	04 Marks

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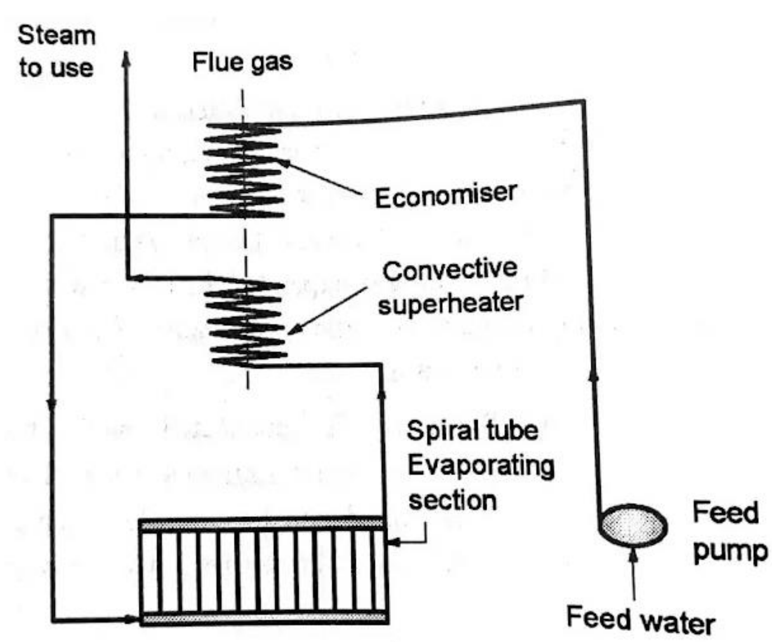
4	e	**Load factor** Load factor is the ratio of average load to the maximum demand Load Factor = average load / maximum demand Higher the load factor laser will be the cost of power generation per kwh **Average load** Average load is calculated by dividing the area under the load curve (energy in kilowatt) by the time period considered to draw the load curve Average load = area under the load curve / 24 = Energy consume in 24 hours / 24	02 Marks 02 Marks
5	a	Ramsin Boiler.  	02 Marks (03 M for figure)

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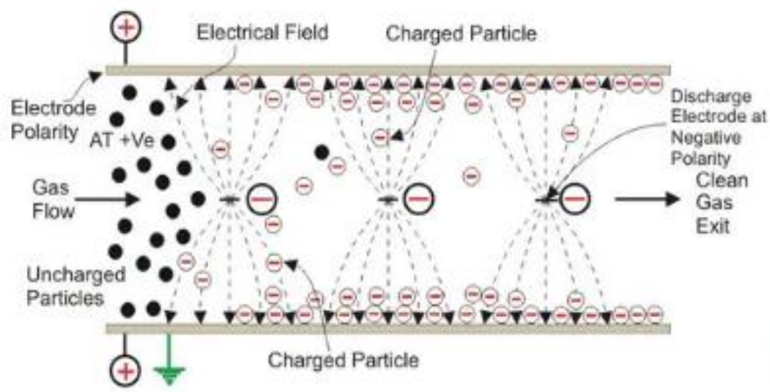
5	A	Construction details The boiler consists of inclined evaporator coil arranged in spiral tube evaporating section. Forty such coils is paralleled around the furnace. Water is forced into the economizer by a feed water pump where it is heated and then it enters in spiral evaporator tube where water flashes to steam. Steam generated in evaporator flows into headers and then convection super heaters. The superheated steam is utilized for power generation.	02 Marks (03 M for construction details)
	b	Electrostatic precipitator  	03 Marks
		Working The unclean flue gas flowing through the passage is supplied to two electrodes, oppositely charged. The gases become ionized because of high applied voltage. as air is passed through this ionized chamber both positive and negative ions are formed. The ionized air is made to pass through the collecting unit consisting of metal plates spaced to 15 to 20 cm apart. The positive plates are near the wall and negative electrodes at the Centre negative and moves to a positive electrode, while positive ions move to negative electrodes. The dust particles collected is clean by shaking motion or light rammers driven by cams. The dust removed from plates is collected in hopers and dump in dumping sites.	03 Marks

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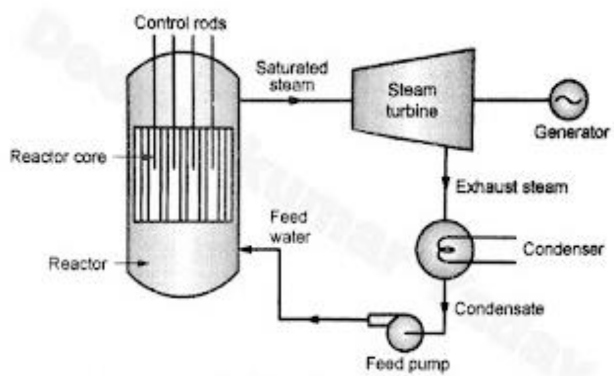
5	C	**BWR power plant**  Advantages of BWR power plant • pressure inside the vessel is low 7 to 8 MPa • power generated per unit fuel is more • No heat exchanger required • Pressurizer is not required • steam temperature at the exit is low that is 285°c • control rods are inserted from below • cost of BWR is comparatively low • thermal efficiency is more as compared to PWR	03 Marks 03 Marks

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Q. No.	Sub Q. N.	Answer	Marking Scheme
6	a	**Indian boiler regulations act** Objectives • Provide for the safety of life limb and property • create a board for boiler rules to serve the society • to formulate rules and regulation for safe and proper construction, installation, repair, use and operation of boilers and unfired pressure vessels • provide for examination and appointment of boiler inspectors • inspection of boilers, inspection certificate • provide for appeals, penalty for the violation of the provisions of the act Provisions of IBR • registration with chief inspector of boilers • determination of maximum working pressure by the boiler inspector and obtaining a certificate • reporting to authority in case of accident within 24 hours • periodic checkup by boiler inspector Boiler inspection • The inspectors appointed by each government carry out normally inspection the inspection includes first check up after the boiler is completely taken to examine defective design if any or damaged during hydraulic pressure and issue of a certificate and registration number • The hydraulic test checks the tightness of boiler joints, setting of leakage during repair after completely feeling with pressure as 1.5 times the working pressure • The steam test is carry out to check the setting of safety valve at the working pressure and sealing the same • Inspection under steam is done in case where the boiler cannot be stop for some reason • Internal inspection is taken when internal parts like tube are taken out from boiler for repair and renewal • To check the observance of rules • Surprise inspection are also done • In case of accident the inspector held an enquiry at site to access the cause of accident and damage to boiler or person	02 Marks 02 Marks 02 Marks

Q. No.	Sub Q. N.	Answer	Marking Scheme
6	b	Maintenance procedure of gas power Main Parts to be maintain are • compressor • combustion chamber • turbine • the electric generator Maintenance of compressor • compressor section repairs can be done by the removal of the compressor valves • air leaks and compressor contamination can be removed by welding and grinding or replacing the entire rotor assembly • lose objects left in air intake causes heavy damage to compressor solution to this problem is to check tool list • compressor wash increases the efficiency Maintenance of combustion chamber • The combustion section consists of liner, support duct, outer and inner case and first stage turbine nozzle assembly • inspection of Liner for cracks, cracks more than 0.125" are fusion welded and grinded for size • file out any distorted hole as a result of welding Turbine section repairs • Turbine consists of turbine rotoer with blades, stator with blades which suffer from high temperature • turbine rotor is repaired by changing individual blade or an individual rotor • turbine blades are coated with protective coating to prevent sulfidation • inspect the blades for hairline cracks • blend minor dents with fine stones or emery clothes • replace bowed vanes Lubrication and cooling system • visual condition of shaft journals • journal bearing clearance and conditions • major and record turbine axial thrust and lift • The electric generator • Dissemble generator and remove field • inspect bearing sleeves oil sealess and all rotating components • inspect stator and field	01 mark 01 mark 01 mark 01 mark 01 mark 01 mark

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Q. No.	Sub Q. N.	Answer	Marking Scheme
6	c	Q 6 (C) 1). Annual energy Production – Load factor $= \frac{\text{Average Load}}{\text{Maximum demand}}$ $0.75 = \frac{\text{Average load}}{50\times10^3}$ ∴ Average load $= 0.75\times50\times10^3$ $= 37.5\times10^3$ kW Annual energy production = Average load × No. of hrs/year $= 37.5\times10^3 \times 24\times365 = 328500\times10^3$ kWh $= 328.5\times10^6$ kWh — 2 marks	02 marks
		2) Reserve capacity above peak load – Capacity factor $= \frac{\text{Average demand per year}}{\text{Rated capacity} \times \text{No. of hours per year}}$ Rated capacity $= \frac{\text{Average demand per year}}{\text{Capacity factor} \times \text{No of hrs per year}}$ $= \frac{328.5\times10^6}{0.6\times8760} = 62.5\times10^3$ kW Reserve Capacity = Rated Capacity − Max. Demand $= 62.5\times10^3 - 50\times10^3 = 12.5\times10^3$ kW — 2 marks = 12.5 MW	02 marks
		3). Hours per year plant is not in use – Use factor $= \frac{\text{Annual Energy Production}}{\text{Rated Capacity} \times \text{No. of Hrs plant is working per year}}$ $0.65 = \frac{328500\times10^3}{62.5\times10^3\times t}$ $t = \frac{328500\times10^3}{62.5\times10^3\times0.65} = 8086$ hrs. Number of hours plant not in use $= 8760 - 8086 = 674$ Hours. 2 marks	02 marks