

POWER PLANT ENGINEERING
ANSWER KEY & SCHEME OF VALUATION

1	Idukki/pallivasal/sabarigiri/		1
2	Quality of Gasoline /petrol		1
3	Gross head		1
4	To maintain speed and load		1
5	Pelton turbine		1
6	Heavy water		1
7	Critical size		1
8	Pressurized Water Reactor		1
9	Artificial lake/cooling ponds/cooling towers		1
PART=B			
1	The calorific value (briefly written as C.V.) or heat value of a solid or liquid fuel may be defined as the amount of heat given out by the complete combustion of 1 kg of fuel. It is expressed in terms of kJ/kg of fuel. The calorific value of gaseous fuels is, however, expressed in terms of kJ/m ³ at a specified temperature and pressure.		3
2	<ol style="list-style-type: none"> 1. A good fuel should have a low ignition point. 2. It should have a high calorific value. 3. It should freely burn with a high efficiency, once it is ignited. 4. It should not produce harmful gases. 5. It should produce least quantity of smoke and gases. 6. It should be economical, easy to store and convenient for transportation. 	An y 3	3
3	<ol style="list-style-type: none"> 1)High head turbine (above 300M) 2)Medium head turbine (80 -300 M) 3)Low head turbine (below 80 M) 		3
4	<ol style="list-style-type: none"> 1. Water the working fluid is natural and available plenty. 2. Life of the plant is very long. 3. Running cost and maintenance are very low. 4 Highly reliable. 5. Running cost is low. 6 Maintenance and operation costs are very less. 7. No fuel transport problem. 8. No ash disposal problem 	An y 3	3
5	<p>Displaying the information about oil handling hazards and way of handling and storing.</p> <ul style="list-style-type: none"> • Storing the oil in a properly Sealed tank either in open or in the ground. • The tanks should be surrounded by oil tight Bond walls to prevent the leakage. <p>Development of skills to the worker for handling the oil in case of leakage.</p> <ul style="list-style-type: none"> • Implementing the TQM for the production of tanks • Before filling the oil in a tank, proper inspection should be carried out to achieve the same quality as per the standards. <ul style="list-style-type: none"> • If there are open storage tank, then the electrical equipment within the space must meet the appropriate safety standards. • The fuel storage and transfer line temperature should not exceed 50 to 55 degree Celsius. • Smoking and carrying matches should not be permitted around the Storage area. <ul style="list-style-type: none"> • Material safety data should be maintained. • Non-Intrinsically, battery operated items example flashlight, mobile phone, camera, pagers extra are not permitted. 	An y 3 po int s 3 ma rks	3
6	Cooling towers, cooling pond, artificial lakhes,spray ponds		3
7	The function of moderator is to slow down the fast fission neutrons travelling at 4200 km/s to about 1.5 km/s before subsequent fission occurs		3

POWER PLANT ENGINEERING
ANSWER KEY & SCHEME OF VALUATION

8	Greenhouse effect is the process by which radiations from the sun are absorbed by the greenhouse gases and not reflected back into space. This insulates the surface of the earth and prevents it from freezing.	3	
9	<ol style="list-style-type: none"> 1. The only precaution that we can take against acid rain is having a check at the emission of oxides of nitrogen and sulphur. 2. Acid rain is harmful to animals, plants and the monuments. 3. Being responsible citizens, one should be aware of the harmful effects they cause and of the industries which give out nitrogen and sulphur compound wastes unethically. 	3	
10		3	
	PART -C		
1	<p><i>Merits</i></p> <ol style="list-style-type: none"> 1. Higher calorific value. 2. Lower storage capacity required. 3. Better economy in handling. 4. Better control of consumption by using valves. 5. Better cleanliness and freedom from dust. 6. Practically no ashes. 7. Non-deterioration in storage. 8. Non-corrosion of boiler plates. 9. Higher efficiency. <p><i>Demerits</i></p> <ol style="list-style-type: none"> 1. Higher cost. 2. Greater risk of fire. 3. Costly containers are required for storage and transport. 	7	
2	<p>The diagram illustrates the components and flow of a diesel power plant. On the left, an 'All day tank' feeds into a 'Fuel transfer pump' which leads to a 'Filter (strainer)'. Below this is a 'Fuel storage tank'. 'Starting air' is drawn from an 'Air compressor' through a 'Filter' into the 'Diesel engine'. The 'Diesel engine' is connected to a 'Generator' and a 'Silencer (muffler)'. It also has a 'Fuel injection pump' and a 'Filter'. The engine's cooling system includes 'Hot water out' and 'Water in' connections, a 'Jacket circulation pump', and a 'Cooling tower'. The lubrication system features a 'Lubricating oil tank', an 'Oil pump', and an 'Oil cooler' with 'Hot oil out' and 'Cool oil in' connections. A 'Condensator' is connected to the cooling system, and a 'Raw water pump' feeds into it.</p>	3	7
	1) Engine is the heart of a diesel power plant. Engine is directly connected through a gear box to the generator. Generally two-stroke engines are used for power generation. Now a days advanced super & turbo charged high	4	

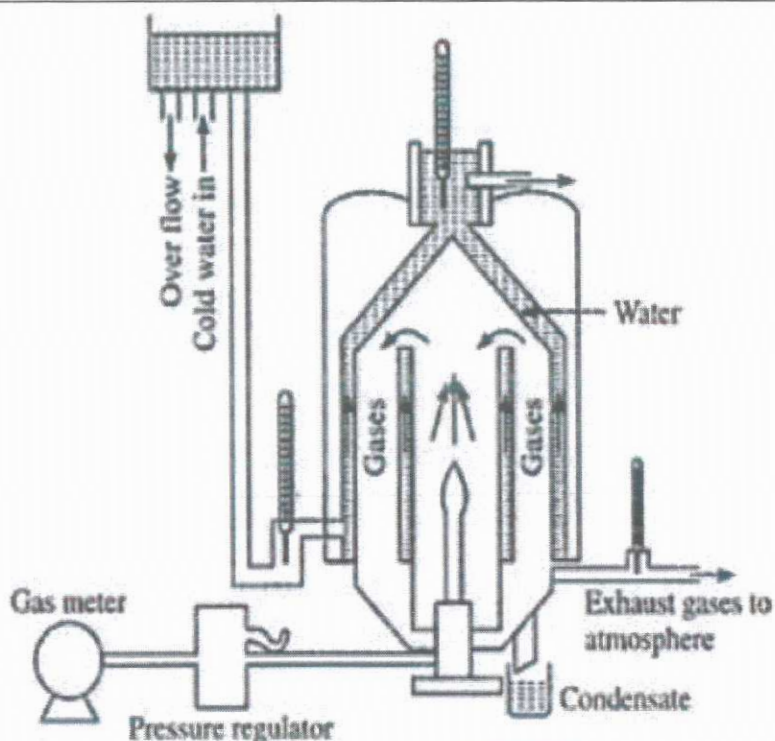
POWER PLANT ENGINEERING
ANSWER KEY & SCHEME OF VALUATION

	<p>speed engines are available for power production.</p> <ol style="list-style-type: none"> 2) Air supply system Air inlet is arranged outside the engine room. Air from the atmosphere is filtered by air filter and conveyed to the inlet manifold of engine. In large plants supercharger/turbocharger is used for increasing the pressure of input air which increases the power output. 3) Exhaust System This includes the silencers and connecting ducts. The heat content of the exhaust gas is utilized in a turbine in a turbocharger to compress the air input to the engine. 4) Fuel System It consists of storage tank, strainers, fuel transfer pump and all day fuel tank. The fuel oil is supplied at the plant site by rail or road. This oil is stored in the storage tank. From the storage tank, oil is pumped to smaller all day tank at daily or short intervals. From this tank, fuel oil is passed through strainers to remove suspended impurities. The clean oil is injected into the engine by fuel injection pump. 5) Cooling system This system includes water circulating pumps, cooling towers, water filter etc. Cooling water is circulated through the engine block to keep the temperature of the engine in the safe range. 6) Lubricating system Lubrication system includes the air pumps, oil tanks, filters, coolers and pipe lines. Lubricant is given to reduce friction of moving parts and reduce the wear and tear of the engine parts. 7) Starting System There are three commonly used starting systems, they are; <ol style="list-style-type: none"> 1) A petrol driven auxiliary engine 2) Use of electric motors. 3) Use of compressed air from an air compressor at a pressure of 20 Kg/cm. 8) Governing system The function of a governing system is to maintain the speed of the engine constant irrespective of load on the plant. This is done by varying fuel supply to the engine according to load 		
3		3	7
	<ol style="list-style-type: none"> 1. Reservoir: water harvested from the catchment area is stored in the reservoir which is then used to generate the electricity. 2. Dams : They are structures built over rivers to stop the water flow and form a reservoir. The reservoir stores the water flowing down the river. This water is diverted to turbines in power stations. The dams collect water during the rainy season and store it, thus allowing for a steady flow through the turbines throughout the year. Dams are also used for controlling floods and irrigation. The dams should be water-tight and should be able to withstand the pressure exerted by the water on 	4	

POWER PLANT ENGINEERING
ANSWER KEY & SCHEME OF VALUATION

	<p>it. There are different types of dams such as arch dams, gravity dams and buttress dams. The height of water in the dam is called head race.</p> <p>3. Spillways: Spillways are made to make the dam safe. When level of water is exceeds some defined point, it will discharge through these spillways.</p> <p>4. Fore bay: when there is sudden change in the turbine load, in such cases there is need of temporary storage of water. This temporary storage of water near turbine is called as fore bay.</p> <p>5. Surge Tank: Surge tanks are tanks connected to the water conductor system. It serves the purpose of reducing water hammering in pipes which can cause damage to pipes. The sudden surge of water in penstock is taken by the surge tank, and when the water requirements increase, it supplies the collected water thereby regulating water flow and pressure inside the penstock.</p> <p>6. Penstock: it is water pipeline carrying water from dam to turbine.</p> <p>7. Prime mover or turbine: it is the main part of the power station. It is coupled with the generator. Turbine is rotated by the flow of water. As it is coupled with the generator, generator also rotates which produces electricity.</p> <p>8. Power Station: Power station contains a turbine coupled to a generator. The water brought to the power station rotates the vanes of the turbine producing torque and rotation of turbine shaft. This rotational torque is transferred to the generator and is converted into electricity.</p> <p>9. Tail races: The used water is released through the tail race. The difference between head race and tail race is called gross head and by subtracting the frictional losses we get the net head available to the turbine for generation of electricity.</p>		
4	<ol style="list-style-type: none"> 1. The supply of fuel gas, and hence the temperature of furnace is easily and accurately controlled. 2. The high temperature is obtained at a moderate cost by pre-heating gas and air with heat of waste gases of combustion. 3. They are directly used in internal combustion engines. 4. They are free from solid and liquid impurities. 5. They do not produce ash or smoke. 6. They undergo complete combustion with minimum air supply. 	5	7
	<ol style="list-style-type: none"> 1. They are readily inflammable. 2. They require large storage capacity. 	2	
5		4	7

POWER PLANT ENGINEERING
ANSWER KEY & SCHEME OF VALUATION



A measured quantity of gas whose calorific value is to be determined is filled to the gas burner via a gas meter which reads its volume and a gas pressure regulator which measures the pressure of the gas by means of a manometer. When the gas burns the hot products of combustion travel upwards in the chamber, and then downwards through the flues, and finally escape to the atmosphere through the outlet.

The temperature of the escaping gas is recorded by the thermometer fitted at the exit, and this temperature should be as close to the room temperature as possible so that entire heat of combustion is absorbed by water. Cold water enters the calorimeter near the bottom and leaves near the top. Water which is formed by condensation of steam is collected in a container.

The quantity of gas used during the experiment is accurately measured by the meter and temperature of incoming and outgoing waters are indicated by the thermometers. From the data (given above) calorific value of gas can be determined.

3

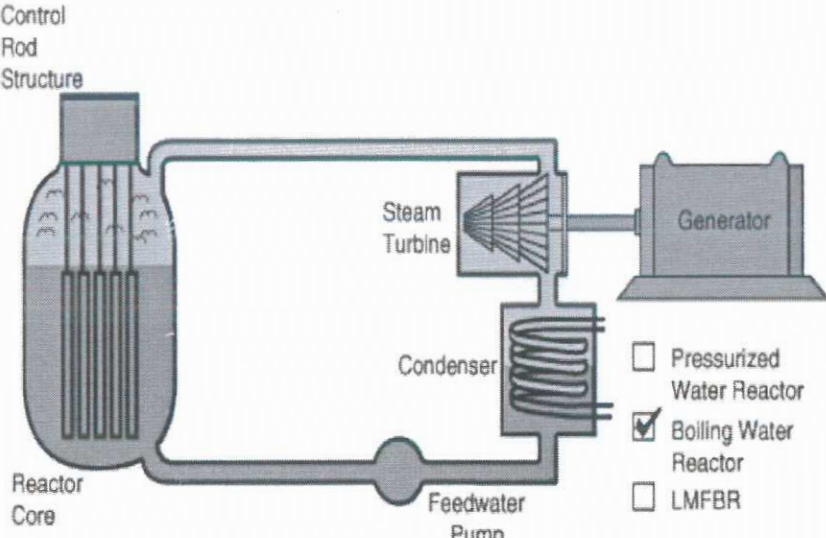
6

Advantages

1. Plant layout is simple. Hence it can be quickly installed and commissioned, while the erection and starting of a steam power plant or hydro-plant takes a fairly long time.
2. Quick starting and easy pick-up of loads are possible in a very short time.
3. Location of the plant is near the load center.
4. The load operation is easy and requires minimum labors.
5. Efficiency at part loads does not fall so much as that of a steam plant.
6. Fuel handling is easier and no problem of ash disposal exists.
7. The plant is smaller in size than steam power plant for same capacity.
8. Diesel plants operate at high overall efficiency than steam.

An
y
7
po
int
s
7
ma
rks

POWER PLANT ENGINEERING
ANSWER KEY & SCHEME OF VALUATION

	<p>Disadvantages</p> <ol style="list-style-type: none"> 1. Plant capacity is limited to about 50 MW of power. 2. Diesel fuel is much more expensive than coal. 3. The maintenance and lubrication costs are high. 4. Diesel engines are not guaranteed for operation under continuous, while steam can work under 25% of overload continuously. 5. Life of plant is low compared to steam power plant. 6. Not guaranteed for operation under continuous overloads. 7. Noise is a serious problem in diesel power plant. 8. Diesel power plant cannot be constructed for large scale 		
7	<p>Fission is a process of splitting a heavy nucleus into two other nuclei. For example, when Uranium nucleus ($Z=92$) is bombarded with a neutron, it is split up into two fragments called Barium ($Z=65$) and Krypton ($Z = 36$). In this process three additional neutrons are liberated from the nucleus of Uranium, atom followed by the release of enormous heat energy</p> <p>Fusion is the process of forcing together two light atoms to make a heavier atom. Fusion produces much more heat than fission. It is believed to be the main source of energy for the sun and stars. Fusion reactions are possible only at very high temperatures ($\sim 10^8$ K) and are also known as thermonuclear reactions. We have, at present, nuclear plants adopting nuclear fission only</p> <p>chain reaction is a chemical or nuclear reaction, in which a neutron colliding with an atomic nucleus causes fission and the ejection of one or more other neutrons, which induce other nuclei to split</p> <p>The three additional neutrons emitted during above nuclear reaction are called secondary neutrons. They, in turn, can cause fission in the neighbouring nuclei, producing more and more secondary neutrons. This is called chain reaction. Which continues until whole of the fissionable material undergoes fission. Chain reaction produces tremendous amount of energy in a very short interval of time</p>	2+ 2+ 2+ 1	
8		3	
	<p>This design has many similarities to the PWR, except that there is only a single circuit in which the water is at lower pressure (about 75 times atmospheric pressure) so that it boils in the core at about 285°C. The reactor is designed to operate with 12-15% of the water in the top part of the core as steam, and hence with less moderating effect and thus efficiency there. The steam passes through drier plates (steam separators) above the core and then directly to the turbines, which are thus part of the reactor circuit. Since the water around the core of a reactor is always contaminated with traces of radionuclide, it means that the turbine must be shielded</p>	4	

POWER PLANT ENGINEERING
ANSWER KEY & SCHEME OF VALUATION

	and radiological protection provided during maintenance. Most of the radioactivity in the water is very short-lived, so the turbine hall can be entered soon after the reactor is shut down.		
9	<p>Uranium-235</p> <ul style="list-style-type: none"> • The most often isotope of Uranium found in Nature is U-238, U-235 is only found in low proportions (0.71%). • U-235 is created from U-238 via isotope separation. • The critical mass for an unreflected sphere of U-235 is about 50 kg (17 cm of diameter). <p>Plutonium is very rare in nature.</p> <ul style="list-style-type: none"> • For military purposes, it is obtained processing Uranium-238 in breeder reactors. • It has a reasonably low rate of neutron emission due to spontaneous fission. • It is usually contaminated with Plutonium-240 which is more unstable (4%- 7% of plutonium-240 is considered bomb-grade). This is the reason why plutonium-based weapons must be implosion-type, rather than gun-type. <p>Thorium is a basic element of nature, like Iron and Uranium. Like Uranium, its properties allow it to be used to fuel a nuclear chain reaction that can run a power plant and make electricity Reactors that use thorium are operating on what's called the Thorium-Uranium (Th-U) fuel cycle. The vast majority of existing or proposed nuclear reactors, however, use enriched uranium (U-235) or reprocessed plutonium (Pu-239) as fuel (in the Uranium-Plutonium cycle), and only a handful have used thorium</p>	2+ 2+ 3	
10	<p style="text-align: center;">PRESSURIZED WATER REACTOR</p> <p>The diagram illustrates the PWR system components: Control Rod Structure, Reactor Core, Primary Loop, Secondary Loop, Steam Turbine, Generator, Condenser, and Feedwater Pump. A legend shows: <input checked="" type="checkbox"/> Pressurized Water Reactor, <input type="checkbox"/> Boiling Water Reactor, and <input type="checkbox"/> LMFBR.</p>	4	
	<p>The design of PWRs originated as a submarine power plant. PWRs use ordinary water as both coolant and moderator. The design is distinguished by having a primary cooling circuit which flows through the core of the reactor under very high pressure, and a secondary circuit in which steam is generated to drive the turbine. A PWR has fuel assemblies of 200-300 rods each, arranged vertically in the core, and a large reactor would have about 150-250 fuel assemblies with 80- 100 tonnes of uranium. Water in the reactor core reaches about 325°C, hence it must be kept under about 150 times atmospheric pressure to prevent it boiling. Pressure is maintained by steam in a pressuriser (see diagram). In the primary cooling circuit the water is also the moderator, and if any of it turned to steam the fission reaction would slow down. This negative feedback effect is one of the safety features of the type. The secondary shutdown system involves adding boron to the primary circuit. The secondary circuit is under less pressure and the water here boils in the heat exchangers which are thus steam generators. The steam drives the turbine to produce electricity, and is then condensed and returned to the heat exchangers in contact with the primary circuit.</p>	3	

POWER PLANT ENGINEERING
ANSWER KEY & SCHEME OF VALUATION

11	<ol style="list-style-type: none"> 1. Burning of Fossil Fuels Transportation and power generation both rely on fossil fuels. When fossil fuels are burned, carbon dioxide is released. As the world's population has expanded, so has the use of fossil fuels. As a result, the atmospheric concentration of greenhouse gases has risen. 2. Deforestation Plants take carbon dioxide and release it as oxygen. Cutting down trees causes a huge increase in greenhouse gases, which causes global warming. 3. Farming Fertilizers include nitrous oxide, which adds to the greenhouse effect on the environment. 4. Industrial Waste and Landfills Industries and industries emit hazardous gases into the atmosphere. Landfills also emit CO₂ and methane, both of which contribute to global warming. 	7
12	<p>Demonstration of organization commitments to the safety priorities.</p> <ul style="list-style-type: none"> • Defining and providing clear authority and responsibility for every organization and employees of the power plant. • Providing assistance and budgetary support for all safety activities. • Scheduling regular workplace inspection. These may be a visual inspection of facilities, equipment, and the tool to identify hazards, physical deterioration, and defects. • Work observation is developed as ways to monitor. • Conducting courses and training on safety while they are actually working on the job. • Providing well qualified and trained safety staff. • Conducting regular evaluation of employee's opinion about the safety program and safety culture. • Implementing a safety audit for various safety regulation, standards, and codes. <p>Developing real-time safety management information system.</p> <ul style="list-style-type: none"> • Displaying the safety posters at the dangerous places. 	7