WINTER-19 EXAMINATION
Model Answer
Subject Name: Plant Economics and Energy Management **Subject Code:** 22312

Important Instructions to examiners:

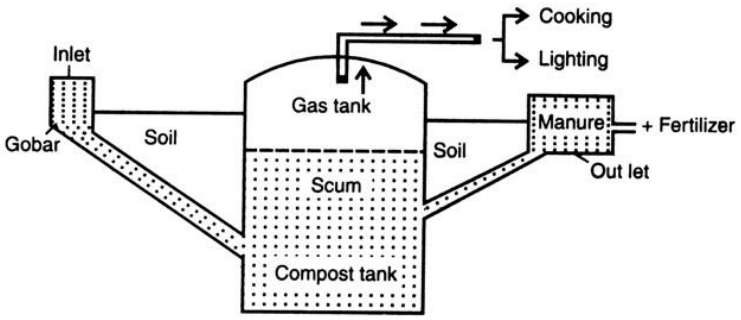
1) The answers should be examined by key words and not as word-to-word as given in the model answer scheme.
2) The model answer and the answer written by candidate may vary but the examiner may try to assess the understanding level of the candidate.
3) The language errors such as grammatical, spelling 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.

Q. No.	Sub Q. N.	Answer	Marking Scheme
1		**Attempt any five of the Following**	10
	a)	**Units of energy:** Joule Calorie Kilowatt Kilowatt-hour Watt	1 mark each for any 2
	b)	**Environmental benefits of Wind Energy (four)** 1. Renewable & Sustainable 2. Environmentally Friendly 3. Reduces Fossil Fuel Consumption 4. Small Footprint	½ mark each
	c)	**Use of lux meter** – to measure intensity of light **Use of tachometer** – to measure speed	1 mark each
	d)	**Types of Cost** Total Cost	1 mark each for

		Fixed Cost Variable cost Direct cost Indirect Cost	any 2
	e)	**Balance sheet** It is a statement of the assets, liabilities, and capital of a business or other organization at a particular point in time, detailing the balance of income and expenditure over the preceding period.	2
	f)	**Factors affecting cost estimation** 1) Labor Wage Rates 2) Inflation Factor 3) Project Schedule 4) Quality of Plans & Specifications 5) Reputation of Engineer 6) Regulatory Requirements 7) Insurance Requirements 8) Size and Type of Project 9) Location 10) Contingency	1 mark each for any 2
	g)	**Objective of energy audit** • To determine ways to reduce energy consumption per unit of product output or to lower operating costs. • Energy Audit provides a "bench-mark" (Reference point) for managing energy in the organization and also provides the basis for planning a more effective use of energy throughout the organization. • Provide detailed documentation for monitoring of energy use	1 mark each for any 2
2		**Attempt any three of the following**	**12**
	a)	**Types of energy Source** **Primary energy source** is an energy form found in nature that has not been subjected to	2 mark each for

		any conversion or transformation process. The primary energy sources are derived from: the sun, the earth's heat, the wind, water (rivers, lakes, tides, and oceans), fossil fuels - coal, oil, and natural gas, biomass, and radioactive minerals. **Secondary energy source** Secondary energy refers to the more convenient forms of energy which are transformed from other, primary, energy sources through energy conversion processes. Examples are electricity, which is transformed from primary sources such as coal, raw oil, fuel oil, natural gas, wind, sun, streaming water, nuclear power, gasoline etc. **Conventional Energy sources:** These sources are exhaustible after use. e.g Coal, crude oil, Gas **Non-Conventional energy sources:** These sources can renew again and again. e.g Solar, Wind, Biomass, Hydro	any two types
	b)	**Fixed Roof Biogas Plant** **Construction** It consits of inlet tank, digester and outlet tank. Sluury is prepeared in inlet tank. Mass is digeated in digester. Gas is collected at the top dome. Digested mass comes our from outlet tank. Gas is taken out by outlet pipe from top. **Working** • The feed material is mixed with water in the influent collecting tank The fermentation slurry flows through the inlet into the digester. • The bacteria from the fermentation slurry are intended to produce biogas in the digester. • The process of anaerobic digestion occurs in a sequence of stages involving distinct types of bacteria. • Hydrolytic and fermentative bacteria first break down the carbohydrates, proteins and fats present in biomass feedstock into fatty acids, alcohol, carbon dioxide, hydrogen, ammonia and sulfides. • This stage is called "hydrolysis" (or "liquefaction").	2

- Next, acetogenic (acid-forming) bacteria further digest the products of hydrolysis into acetic acid, hydrogen and carbon dioxide.
- Methanogenic (methane-forming) bacteria then convert these products into biogas.
- The combustion of digester gas can supply useful energy in the form of hot air, hot water or steam.



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OR

Floating Roof Biogas Plant

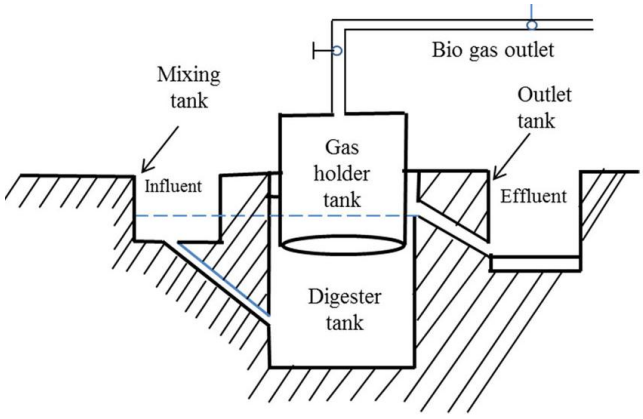
Construction

It consits of inlet tank, digester and outlet tank. The floating gas holder type bio gas plant consists of a dome shaped gas holder made of steel for collecting bio gas. The dome shaped gas holder is not fixed but is moveable and floats over the slurry present in the digester tank. Due to this reason, this biogas plant is called floating gas holder type biogas plant.Digested mass comes our from outlet tank. Gas is taken out by outlet pipe from top.

Working

- The feed material is mixed with water in the influent collecting tank The fermentation slurry flows through the inlet into the digester.
- The bacteria from the fermentation slurry are intended to produce biogas in the digester.
- The process of anaerobic digestion occurs in a sequence of stages involving distinct types of bacteria.

- Hydrolytic and fermentative bacteria first break down the carbohydrates, proteins and fats present in biomass feedstock into fatty acids, alcohol, carbon dioxide, hydrogen, ammonia and sulfides.
- This stage is called "hydrolysis" (or "liquefaction").
- Next, acetogenic (acid-forming) bacteria further digest the products of hydrolysis into acetic acid, hydrogen and carbon dioxide.
- Methanogenic (methane-forming) bacteria then convert these products into biogas.
- The combustion of digester gas can supply useful energy in the form of hot air, hot water or steam.



c) **Energy conservation** — 2

Energy Conservation is the deliberate practice or an attempt to save electricity, fuel oil or gas or any other combustible material, to be able to put to additional use for additional productivity without spending any additional resources or money. Energy is a scarce commodity; Energy in any form is a scarce commodity and an expensive resource. During the last four decades the induction of energy efficient technologies has lead to dramatic reduction in energy usage in chemical process industries. Due to compulsions from global competition to be highly cost competitive and the awareness thereof, companies are on a drive to reduce costs. Energy consumption in Chemical Process Industries (CPI) is dependent on the products manufactured and process employed. Energy cost in caustic chlorine plant is around 60% of the manufacturing cost.

		Importance a) To reduce imports of energy and reduce the drain on foreign exchange. b) To improve exports of manufactured goods (either lower process or increased availability helping sales) or of energy, or both. c) To reduce environmental pollution per unit of industrial output - as carbon dioxide, smoke, sulphur dioxide, dust, grit or as coal mine discard for example. d) Thus reducing the costs that pollution incurs either directly as damage, or as needing, special measures to combat it once pollutants are produced. e) Generally to relieve shortage and improve development. f) Advantage in PAT scheme.	2
	d)	**Profitability by ROI** Return on investment, or ROI, is the most common profitability ratio. There are several ways to determine ROI, but the most frequently used method is to divide net profit by total assets. So if your net profit is Rs 100,000 and your total assets are Rs 300,000, your ROI would be .33 or 33 percent. ROI serves as a returns ratio, allowing a business owner to calculate how efficiently the company uses its total asset base to generate sales. Total assets include all current assets such as cash, inventory, and accounts receivable in addition to fixed assets such as the plant buildings and equipment. If an investment doesn't have a good ROI, or if an investor or business owner has other opportunities available with a higher ROI, then calculating the ROI values on the different opportunities can instruct them as to which investments to choose for the best return. Many analysts and investors like to use the ROI metric because of its versatility and simplicity. Essentially, it works as a quick gauge of an investment's profitability, and it's very easy to calculate and interpret for a wide variety of investment types. **Return on investment = (revenue − cost of goods sold) / cost of goods sold**	4
3		**Attempt any three of the following**	**12**
	a)	**Calorific value of fuel** The amount of energy produced by the complete combustion of a material or fuel.	1

Measured in units of energy per amount of material, e.g. kJ/kg.

Difference between NCV and GCV

Gross Calorific Value	Net Calorific Value
The gross heating value is obtained when all products of the combustion are cooled down to the temperature before the combustion considering the water vapor formed during combustion is condensed.	The net or lower heating value is obtained by subtracting the latent heat of vaporization of the water vapor formed by the combustion from the gross or higher heating value.
Value is higher than NCV	Value is lower than GCV
If no hydrogen is present GCV= NCV	More hydrogen is present lower is NCV.
It is not an actual heat available for use.	It is an actual heat available for use.

3

b) **Solar Water Heater**

Construction

2

A typical domestic solar water heater consists of a hot water storage tank and one or more flat plate collectors. Inlet and outlet pipes are connected to water tank which is insulated to avoid heat loss. Material of construction of tube is copper in side collector. Glass cover is provided on the collector. Water is place on the metal structure at the top and flat plate collectors are the bottom facing the sun.

Working

The collectors are glazed on the sun facing side to allow solar radiation to come in. A black absorbing surface (absorber) inside the flat plate collectors absorbs solar radiation and transfers the energy to water flowing through it. A black surface heats up when left in the sun, by absorption of solar radiation; The good absorption property of black surfaces is used to improve solar energy absorption in a solar heater Heated water is collected in the tank which is insulated to prevent heat loss. Circulation of water from the tank through the collectors and back to the tank continues automatically due to density difference between hot and cold water (thermosyphon effect).

2

	c)	**Energy loss and control in any utility** **Energy saving opportunities in cooling tower (These measures will save electrical energy used in fan or pumps)** 1. Follow manufacturer's recommended clearances around cooling towers and relocate or modify structures that interfere with the air intake or exhaust 2. Optimize cooling tower fan blade angle on a seasonal and/or load basis 3. Correct excessive and/or uneven fan blade tip clearance and poor fan balance 4. In old counter-flow cooling towers, replace old spray type nozzles with new square spray nozzles that do not clog 5. Replace splash bars with self-extinguishing PVC cellular film fill 6. Install nozzles that spray in a more uniform water pattern 7. Clean plugged cooling tower distribution nozzles regularly 8. Balance flow to cooling tower hot water basins 9. Cover hot water basins to minimize algae growth that contributes to fouling 10. Optimize the blow down flow rate, taking into account the cycles of concentration (COC) limit 11. Replace slat type drift eliminators with low-pressure drop, self-extinguishing PVC cellular units 12. Restrict flows through large loads to design values **OR** **Energy saving in boiler ((These measures will save electrical energy used in fan or pumps)** 1. Reducing excess air 2. Installing economizer 3. Reducing scale and deposits 4. Reducing blow down 5. Recovering waste heat from blow down 6. Stopping dynamic operation	4 marks will be given to measures for any one utility

		7. Reducing boiler pressure 8. Operating at peak efficiency 9. Preheating combustion air 10. Switching from steam to air atomization Switching to lower cost fuel	
	d)	**Properties of petroleum fuel** **The flash point** of a volatile fuel is the lowest temperature at which it can vaporize to form an ignitable mixture in air. The flash point is an important concept in fire investigation and fire protection because it is the lowest temperature at which a risk of fire exists with a given liquid. It is crucial in many circumstances to establish the presence of some liquids and to know their flash point during the investigation process. **The fire point** of a fuel is the temperature at which the vapour produced by that given fuel will continue to burn for at least 5 seconds after ignition by an open flame. The fire point is the temperature at which lubricant combustion will be sustained. The flash and fire points are useful in determining a lubricants volatility and fire resistance. The flash point can be used to determine the transportation and storage temperature requirements for lubricants. **Viscosity:** Controlling the viscosity of fuel oil is an important aspect of an efficient combustion. A high viscosity fuel oil leads to improper atomization which in turn leads to incomplete combustion. High viscosity fuel prevents correct atomization, which takes place in the fuel injectors. **Specific gravity:** For fuels, specific gravity can be determined by dividing the density of the fuel by the density of water. When it comes to configuring a mixer, knowing the specific gravity of the fluids being blended is important because it will influence the torque & horsepower that is required to properly mix your fluid. In applications with higher specific gravity, more torque would be required to produce the desired result. If specific gravity was not taken into consideration, and a mixer not optimized accordingly, results would be unpredictable, and motor damage and/or failure would likely occur. **Calorific value:** The calorific value or heat of combustion of a fuel oil is a measure of the	1 mark each for any 4

		amount of heat released during complete combustion of a unit mass of the fuel, expressed in kilojoules per kilogram. Calorific value is usually determined by a calorimeter. The combustion process generates water vapor and certain techniques may be used to recover the quantity of heat contained in this water vapor by condensing it. Higher Calorific Value (or Gross Calorific Value – GCV, or Higher Heating Value – HHV) – the water of combustion is entirely condensed and that the heat contained in the water vapor is recovered; Lower Calorific Value (or Net Calorific Value – NCV, or Lower Heating Value – LHV) – the products of combustion contain the water vapor and that the heat in the water vapor is not recovered.	
4		**Attempt any three of the following**	**12**
	a)	**Benefits of Hydrogen Energy** **The use of hydrogen greatly reduces pollution.** When hydrogen is combined with oxygen in a fuel cell, energy in the form of electricity is produced. This electricity can be used to power vehicles, as a heat source and for many other uses. The advantage of using hydrogen as an energy carrier is that when it combines with oxygen the only byproducts are water and heat. No greenhouse gasses or other particulates are produced by the use of hydrogen fuel cells. **Hydrogen can be produced locally from numerous sources.** Hydrogen can be produced either centrally, and then distributed, or onsite where it will be used. Hydrogen gas can be produced from methane, gasoline, biomass, coal or water. Each of these sources brings with it different amounts of pollution, technical challenges, and energy requirements. **If hydrogen is produced from water we have a sustainable production system .** Electrolysis is the method of separating water into hydrogen and oxygen. Renewable energy can be used to power electrolyzes to produce the hydrogen from water. Using renewable energy provides a sustainable system that is independent of petroleum products and is nonpolluting. **Hydrogen energy is non-toxic** This means that it does not cause any harm or destruction	1 mark each for any 4

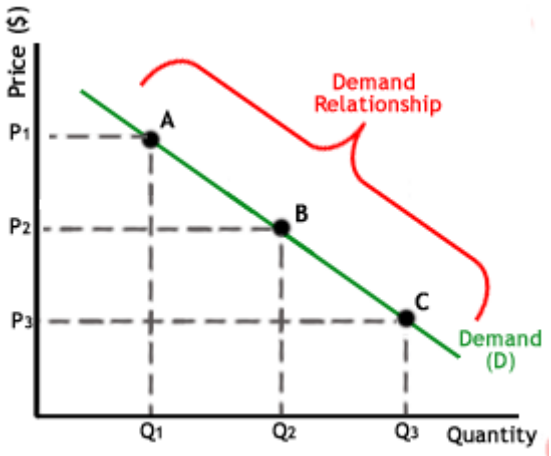
		to human health. This aspect makes it preferred compared to other sources of fuel like nuclear energy, natural gas, which are extremely hazardous or daunting to harness safely. It also allows hydrogen to be used in places where other forms of fuel may not be allowed. **It's far more efficient than other sources of energy** Hydrogen is solidly efficient energy type since it has the ability to convey a lot of energy for every pound of fuel. This categorically means that an automobile that utilizes hydrogen energy will travel more miles than one with an equal amount of gasoline. **Used for powering space ships** Hydrogen energy's efficiency and power makes it an ideal fuel source for spaceships. Its power is so high that it's able to quickly rocket spaceships to exploration missions. It's also the safest form of energy to perform such an energy-intensive task. Hydrogen energy is in fact 3 times more potent than gasoline and other fossil-based sources of fuel. This ideally means that you need less hydrogen to complete an enormous task.	
	b)	**Hydropower plant** **Advantages** • Renewable - Hydroelectric energy is renewable. This means that we cannot use up. However, there's only a limited number of suitable reservoirs where hydroelectric power plants can be built and even less places where such projects are profitable. • Green - Generating electricity with hydro energy is not polluting itself. The only pollution occurs during the construction of these massive power plants. • Reliable - Hydroelectricity is very reliable energy. There are very little fluctuations in terms of the electric power that is being by the plants, unless a different output is desired. Countries that have large resources of hydro power use hydroelectricity as a base load energy source. As long as there is water in the magazines electricity can be generated. • Flexible - As previously mentioned, adjusting water flow and output of electricity is easy. At times where power consumption is low, water flow is reduced and the	2 marks for any 2 advantages + 2 marks for any 2 disadvantages

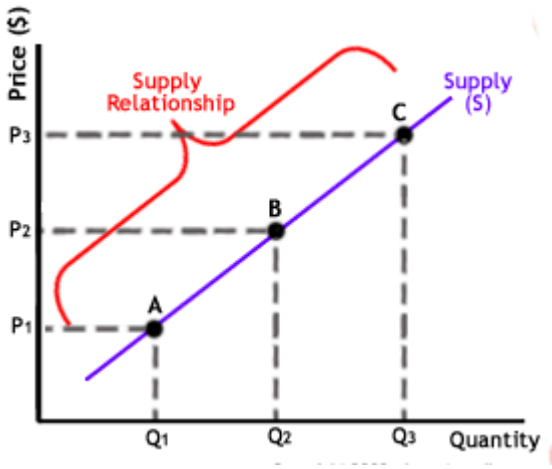
		magazine levels are being conserved for times when the power consumption is high. • Safe - Compared to among others fossil fuels and nuclear energy, hydroelectricity is much safer. There is no fuel involved (other than water that is). **Disadvantages** • Environmental Consequences - The environmental consequences of hydro power are related to interventions in nature due to damming of water, changed water flow and the construction of roads and power lines. • Expensive - Building power plants in general is expensive. Hydroelectric power plants are not an exception to this. On the other hand, these plants do not require a lot of workers and maintenance costs are usually low. • Droughts - Electricity generation and energy prices are directly related to how much water is available. A drought could potentially affect this. • Limited Reservoirs - We have already started using up suitable reservoirs for hydroelectric power plants. There are currently about 30 major power plants that are expected to generate more than 2.000 MW under construction. Only one of these projects was started in the last two years.	
	c)	**Responsibilities and Duties of Energy Manager** **Responsibilities** • Prepare an annual activity plan and present to management concerning financially attractive investments to reduce energy costs • Establish an energy conservation cell within the firm with management's consent about the mandate and task of the cell. • Initiate activities to improve monitoring and process control to reduce energy costs. • Analyze equipment performance with respect to energy efficiency • Ensure proper functioning and calibration of instrumentation required to assess level of energy consumption directly or indirectly. • Prepare information material and conduct internal workshops about the topic for other	2 marks for any 2 duties and 2 marks for any 2 responsibilities

		staff. • Improve disaggregating of energy consumption data down to shop level or profit center of a firm. • Establish a methodology how to accurately calculate the specific energy consumption of various products/services or activity of the firm. • Develop and manage training programme for energy efficiency at operating levels. • Co-ordinate nomination of management personnel to external programs. • Create knowledge bank on sectoral, national and inter-national development on energy efficiency technology and management system and information denomination • Develop integrated system of energy efficiency and environmental up gradation. • Co-ordinate implementation of energy audit/efficiency improvement projects through external agencies. • Establish and/or participate in information exchange with other energy managers of the same sector through association **Duties** • Report to BEE and State level Designated Agency once a year the information with regard to the energy consumed and action taken on the recommendation of the accredited energy auditor, as per BEE Format. • Establish an improved data recording, collection and analysis system to keep track of energy consumption. • Provide support to Accredited Energy Audit Firm retained by the company for the conduct of energy audit • Provide information to BEE as demanded in the Act, and with respect to the tasks given by a mandate, and the job description. • Prepare a scheme for efficient use of energy and its conservation and implement such scheme keeping in view of the economic stability of the investment in such form and manner as may be provided in the regulations of the Energy Conservation Act.	
	d)	**Detailed Energy Audit** Detailed audit provides a detailed project implementation plan for a facility, since it	4

		evaluate all major energy using systems. This type of audit offers the most accurate estimate of energy savings and cost.it considers the interactive effects of all projects, accounts for the energy use of all major equipments , and include detailed energy cost saving calculation and project cost. Detailed audit is carried out in three phases: Phase I : pre audit phase Phase II : audit phase Phase III : post audit phase Detailed energy audit includes a complete description of the facility, including an equipment inventory, an energy balance, detailed energy savings and costs associated with each low-cost and not-cost measure, financial analysis of each recommended measure, identification and rough estimates of capital project costs and savings. Energy savings and economic feasibility are determined as accurately as possible. The reports contain more detailed descriptions of the measures. The portable instruments, trend logs and data loggers are used in detailed energy audits for assessing the current performance accurately .The scope of an energy audit includes an examination of the following areas: Energy generation/conversions equipments like boilers, furnaces, Heaters ,pumps, fans, compressors, transformers etc. Energy distribution network of electricity, water, steam, condensate, compressed air etc. Energy utilization efficiency of all equipment and buildings. Efficient planning, operation, maintenance and housekeeping Management aspects of design and operating data collection, field measurements, data analysis, and training	
	e)	**Given data** Quantity of solid fuel = m1 = 1200 kg/hr	

		Calorific value of solid fuel = CV1= 9800 kcal/kg Total heat produced = m1 x CV1 = 1200 x 9800 = 11760000 kcal Total Cost of solid fuel C1 =1200 x 20 = Rs. 24000 Biomass fuel required = Total heat produced / CV2 Calorific value of biomass fuel = 7200 kcal/kg Biomass fuel required = 11760000/7200 = 1633.33 kg/hr Total Cost of biomass fuel = 1633.33 x 11 = Rs.17966.66 Saving in fuel cost = 24000 -17966.66 = Rs. 6033.33 **% saving = 25.13%**	1 1 1 1
5		**Attempt any two of the following**	**12**
	a)	**Total cost** Total cost refers to total expense incurred in reaching a particular level of output, if such total cost is divided by quantity produced average or unit cost is obtained. The total cost includes both the variable cost (that varies with the change in the total output) and the fixed cost (that remains fixed irrespective of the change in the total output). Thus, total cost includes the cost of all the input factors used for producing a certain level of output. **Fixed Cost** A cost that remains constant within a given period of time and range of activity in spite of fluctuations in production. Per unit fixed cost varies with the change in the volume of production. If the production increases, fixed cost per unit decreases and as there is decrease in production, the fixed cost per unit increases. Rent and insurance of building, depreciation on plant and machinery, salary of employees etc., are some examples of fixed costs. **Variable cost** Variable costs are those cost which vary directly in proportion to change in volume of production/output. The cost which increases or decreases in the same proportion in which the units produced is termed as variable cost. Direct material, direct labour, direct expenses, variable overheads are some examples of variable cost.	2 2 2

	b)	**The Law of Demand** The law of demand states that, if all other factors remain equal, the higher the price of a good, the less people will demand that good. In other words, the higher the price, the lower the quantity demanded. The amount of a good that buyers purchase at a higher price is less because as the price of a good goes up, so does the opportunity cost of buying that good. As a result, people will naturally avoid buying a product that will force them to forgo the consumption of something else they value more. The chart below shows that the curve is a downward slope. A, B and C are points on the demand curve. Each point on the curve reflects a direct correlation between quantity demanded (Q) and price (P). So, at point A, the quantity demanded will be Q1 and the price will be P1, and so on. The demand relationship curve illustrates the negative relationship between price and quantity demanded. The higher the price of a good the lower the quantity demanded (A), and the lower the price, the more the good will be in demand (C).  **The Law of Supply** Like the law of demand, the law of supply demonstrates the quantities that will be sold at a certain price. But unlike the law of demand, the supply relationship shows an upward slope. This means that the higher the price, the higher the quantity supplied. Producers supply more at a higher price because selling a higher quantity at a higher price increases revenue.A, B and C are points on the supply curve. Each point on the curve reflects a direct correlation between quantity supplied (Q) and price (P). At point B, the quantity	3 3

		supplied will be Q2 and the price will be P2, and so on.  	
	c)	**Given Data** Money deposited =Principle amount = P = Rs. 20000 Interest rate= i = 6 % Period = n = 10 yrs For compounded interest $A = P (1+ i/t)^{nt}$ Where A = Amount payable P = Principle amount n = no of years (loan term) t = No of times interest rate is compounded per year $A = 20000 (1 + 0.06/2)^{10x2}$ **A = Rs. 36122.22**	1 1 1 1 2
6		**Attempt any two of the following**	**12**
	a)	**Process of accounting** An accounting system tracks and controls the income and expenses of a business. Accounting systems can be as simple as a pen and notepad, and can be as complex as an	6

international accounting staff of thousands utilizing the latest technological advancements. For small business owners, following a set of basic accounting principles can be an effective way to gain experience in handling your company's accounts.

Collecting Financial Documents

Financial records are vital in any accounting system. Small and large businesses alike should put systems in place to ensure that all income and expenses are recorded in some way, physically, electronically or both.

Important financial documents include cash register tapes, invoices, incoming bills, salaries records, tax forms and travel receipts. Financial documents can originate from a diverse range of locations and employees. Put a system in place to ensure that these documents make their way to a central accounting department in a timely manner.

Posting Transactions

Traditionally, accountants used financial documents to manually enter transactions into the various accounts in the company's accounting system. While this is still true to a certain extent, a large number of businesses have taken advantage of technological solutions to automatically post transactions.

Proprietary automatic ordering software, for example, can be set up to automatically adjust the accounts in the accounting system via the company network. In this case, accountants use financial documents to verify accounting records and investigate any discrepancies.

Account Reconciliation

Checking your accounts against external records should be a regular activity in an accounting department. Checking internal records of company assets against bank account and investment portfolio statements can alert your accounting team to any differences between the two, as can checking your accounts payable records with your suppliers' records.

Accounts Payable And Receivable

Accounts payable consists of all money owed by your company to its suppliers and lenders. Accounts receivable is the exact opposite, and consists of all money owed to you

		by customers and other debtors. A thorough accounting system involves systems of tracking the due dates and statuses of accounts payable and receivable, and can even be set up to automatically pay bills on time or send notifications to delinquent account holders. ***Internal And External Reporting*** Creating reports for management, investors and other company stakeholders is a vital function of an accounting system. Internal reports aid managers in decision-making by presenting operational data in a strategically relevant manner, allowing them to spot trends and areas of potential improvement. Publicly traded corporations are required to submit a range of financial reports to federal authorities throughout the year, including the annual report, Form 10K. Even privately held companies, however, may find themselves required to create reports for external stakeholders, such as lenders and private investors.	
	b)	**Given data** Cost of equipment = Rs. 15 lakhs Salvage value = Rs. 0 Useful life = n years Depreciation charge for second year = Rs. 3.15 lakhs SYD Depreciation = $\text{Depreciable Base} \times \frac{\text{Remaining Useful Life}}{\text{Sum of the Years' Digits}}$ Depreciation at 2^{nd} year = depreciable value (n-1)/SYD $\text{Sum of the Years' Digits} = \frac{n(n+1)}{2}$ 3.15 =15 x (n-1)/SYD = (15n-1)/SYD 3.15xSYD = 15n-1 $3.15n^2 - 30n + 33.15 = 0$ n = 7 to 8 years approximately	6

		(It is difficult to calculate approximate value , hence procedure of problem solving should be considered)	
	c)	**Given data** Fixed capital investment = Rs. 15 cr Working capital = 20% of fixed capital = Rs. 3 cr Depreciation = 8% of fixed capital = Rs. 1.2 cr Annual profit = Rs. 7 cr $\text{Payout period in years (no interest charge)} = \frac{\text{depreciable fixed-capital investment}}{\text{avg profit/yr + avg depreciation/yr}}$ = (15)/(1.2+7) = **2.083 years**	1 1 2 2