WINTER–18 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)	**Energy Policy** Energy policy is the document used to address issues of energy development/conservation including energy production, distribution and consumption. **Industrial Energy Policy** It the document signed by highest authority in industry which state industries commitment toward energy use and energy conservation. The policy document is displayed everywhere in industry to motivate employees.	2
	b)	**Applications of Solar Energy (Four)** 1. Electricity production by thermal way 2. Electricity production by photovoltaic way 3. Heat production 4. Grain drying 5. Solar water heating	½ mark each for any four

		6. Solar distillation 7. Solar building heating 8. Solar Furnace 9. Solar Cooking	
	c)	**Commercial Energy:** This type of energy is available in the market for define price and it can be traded in the market. Oil, Coal, gas etc **Non Commercial Energy:** This type of energy is not available in the market for define price and it is traded in the market. Agri waste, cow dung, solar etc	½ ½ ½ ½
	d)	**Instruments used for energy audit (four)** 1. Power analyzer 2. IR thermometer 3. Lux meter 4. Tachometer 5. Anemometer 6. IR camera 7. Leak detector 8. Combustion gas analyzer	½ mark each for any four
	e)	**Economics:** Economics is a social science concerned with the production, distribution and consumption of goods and services. Or Economics is a study of mankind in the ordinary business of life; it examines that part of individual and social action which is most closely connected with the attainment and with the use of the material requisites of well being. Or According to Marshall, economics is a study of mankind in the ordinary business of life, i.e., economic aspect of human life	2 for any correct definition

	f)	**Types of Markets** 1. Perfect completion 2. Monopoly 3. Oligopoly 4. Monopolistic Completion 5. Monopsony	½ mark each for any four
	g)	**Types of Cost** Fixed cost : Rent , Salary, Insurance Variable Cost : Raw material , wages, advertising etc	1 1
2		**Attempt any three of the following**	**12**
	a)	**Solar Water Heater** **Construction** 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	2 2

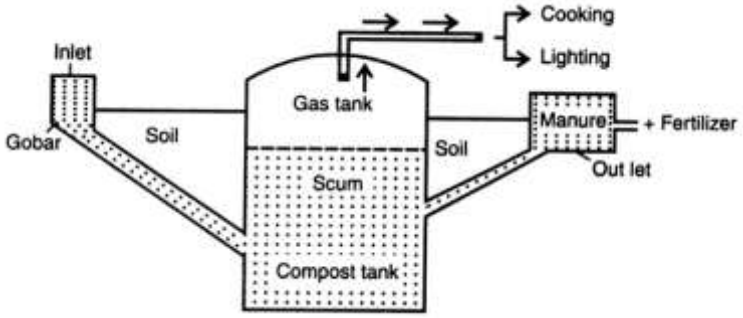
		Heated water is collected in the tank which is insulated to prevent heat loss. Circulation of water from the tank through the collectors and back to the tank continues automatically due to density difference between hot and cold water (thermosyphon effect).	
	b)	**Energy conservation** Energy Conservation 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.	4
	c)	**Clean Energy Technologies** hold a promising solution to meeting our current energy needs in a clean and environmentally friendly way. These renewable resources get their	4

		energy from naturally occurring phenomena such as sunlight, wind, water, biofuels, tidal and wave power, and geothermal heat. • They are sustainable. And because these alternative energy sources are naturally replenished day after day, they are a source of virtually endless energy. • They are environmentally friendly • Their use provides a reduction in greenhouse gas emissions. Since renewable energies don't result in CO2 emissions, they offer a viable solution to this problem. • Their low degree of emission leads to cleaner air. All of the chemical byproducts and substances that are released in the air by the processing and burning of fossil fuels ultimately affect the air we breathe. • They increase our energy security. • They reduce the need for oil drilling. New drilling prospects still exist, but many involve further despoiling of some of the natural wilderness areas we have left. • They provide financial stability for the consumer. • There are often subsidies available. Increasingly, governments worldwide are putting into place significant financial incentives for individual homeowners switching to alternative energy systems. Often this can help offset the initial installation costs of an alternative system. • They have the potential to turn into viable new industries. Many of the companies responsible for the development of alternative energy sources are some of the more fore-thinking and cutting-edge organizations in the world. Plus, all the manufacturing, installation, retrofitting, and so on involved in the use of these systems carries the potential to create many new jobs. • They can save you money. In the end, using alternative energy sources can save you money. Although you typically have to make an initial investment, these types of systems usually pay for themselves over time, given that their primary energy source (i.e. sun or wind) is essentially free.	

	d)	**Depreciation** Depreciation, i.e. a decrease in an asset's value, may be caused by a number of other factors as well such as unfavorable market conditions, etc. Machinery, equipment, currency are some examples of assets that are likely to depreciate over a specific period of time. Opposite of depreciation is appreciation which is increase in the value of an asset over a period of time. Accounting estimates the decrease in value using the information regarding the useful life of the asset. This is useful for estimation of property value for taxation purposes like property tax etc. For such assets like real estate, market and economic conditions are likely to be crucial such as in cases of economic downturn. **Methods** 1. Straight line method 2. Sum of years digit method 3. Sinking Fund method 4. Annuity method 5. Witten down method	2 2
3		**Attempt any three of the following**	**12**
	a)	**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 staff.	2 marks for any 2 duties and 2 marks for any 2 responsibilities

		• 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.	
	b)	**Environmental Benefits of Wind Energy** 1. It can renew again and again. 2. It does not emit greenhouse gases	1 mark for each

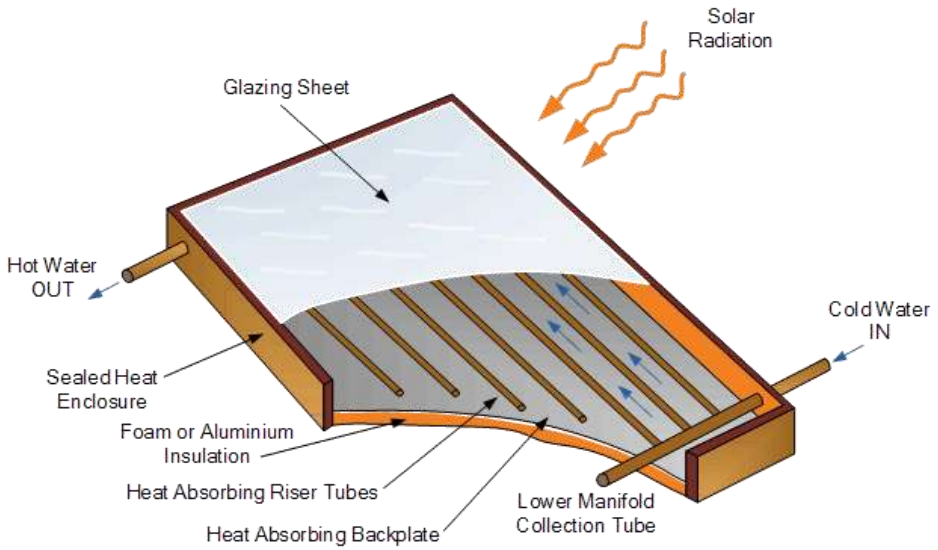
		3. It helps in sustainable development. 4. It reduces fossil fuel exploration, production and transportation	
	c)	**Fixed Roof Biogas Plant** **Construction** It consits of inlet tank, digester and outlet tank. Sluury is prepeared in inlet tank. Mass is digeated in digester. Gas is collected at the top 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”). • 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.	1 2

			1
	d)	**New Energy Sources and Applications** **Antimatter** Antimatter is the Bizarro twin of matter, made up of antiparticles that have the same mass as ordinary matter but with opposite atomic properties known as spin and charge. When the opposed particles meet, they annihilate each other and release tremendous amounts of energy as dictated by Einstein's famous equation, $E= mC^2$. Application : Production of heat **Fuel Cell** Hydrogen fuel cells might seem like the perfect alternative to fossil fuels. They can generate electricity using only hydrogen and oxygen and are pollution free. An automobile running on hydrogen fuel cells would not only be more efficient than one powered by an internal combustion engine, its only emission would be water. Application : Automobile **Ocean Thermal Energy Conversion** Oceans cover 70 percent of the Earth, and water is a natural solar energy collector. OTEC, or ocean thermal energy conversion, aims to exploit this fact and use the temperature differences between surface water heated by the sun and water in the ocean's chilly depths to generate electricity. Application : Production of Electricity **Space-based solar** Most solar energy doesn't actually make it into the Earth's atmosphere, so space-based solar power makes a lot of sense. The challenges are the cost in getting a satellite to orbit, as well as the conversion of electricity into microwaves that can be beamed down	1 mark each for any four

		to the planet's surface. Application : Production of Electricity **Hydrogen power** Hydrogen is a clean and potent source of energy, and best of all – it accounts for 74% of the mass of the entire universe. The only problem is that hydrogen atoms tend to only be found in combinations with oxygen, carbon, and nitrogen atoms. Removing this bond takes energy, which ends up being counter-productive. As a result, many people around the world are working on making these processes more economic. Application : Production of Electricity **Nuclear waste** Only 5% of uranium atoms are used in a traditional fission reaction. The rest end up in the pile of nuclear waste, which sits in storage for thousands of years. Researchers and companies are trying to tap into these leftovers for a viable and economic energy solution. Application : Production of Electricity **Algae power** Algae grows practically anywhere, and it turns out these tiny plants are a surprising source of energy-rich oils. Up to 35000 lit of biofuel could be "grown" per acre, making it one of many potential energy sources of the future. Application : Production of Electricity	
4		**Attempt any three of the following**	**12**
	a)	**Detailed Energy Audit** 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.	4

		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	
	b)	**Commercial Energy:** This type of energy is available in the market for define price and it can be traded in the market. Fossil fuel is available in the ground. These sources need to find out and explore using technology. Various government and private companies are engaged worldwide in this activity. Trillions of dollars are engaged in trading of these fuels. Oil, Coal, gas , electricity etc **Non Commercial Energy:** This type of energy is not available in the market for define price and it is traded in the market. In the village agricultural activities and cattle ranching is major activity. Waste produced during these activities is source of energy in the form of dry wood, bio gas, dry cow dung. But due to its decentralized nature it is not commercially traded. MSW is also source of energy in cities but not commercially traded. Agri waste, cow dung, solar etc	2 2
	c)	**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	1 mark each for any four

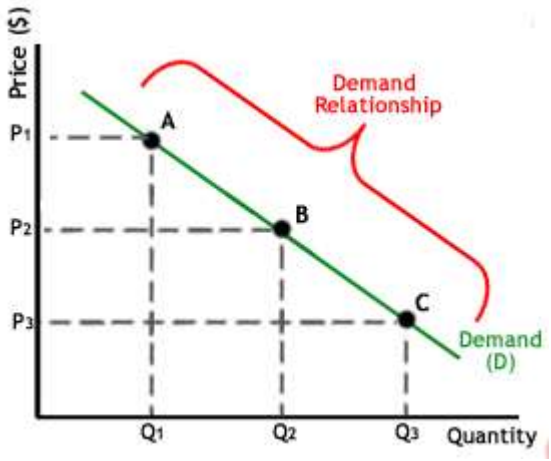
		used to power vehicles, as a heat source and for many other uses. The advantage of using hydrogen as an energy carrier is that when it combines with oxygen the only byproducts are water and heat. No greenhouse gasses or other particulates are produced by the use of hydrogen fuel cells. **Hydrogen can 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 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.	

	d)	**Solar Flat Plate Collector** **Construction** A solar flat plate collector typically consists of a large heat absorbing plate, usually a large sheet of copper or aluminum as they are both good conductors of heat, which is painted and chemically etched black to absorb as much solar radiation as possible for maximum efficiency. This blackened heat absorbing surface has several parallel copper pipes or tubes called risers, running length ways across the plate which contains the heat transfer fluid, typically water. These copper pipes are bonded, soldered or brazed directly to the absorber plate to ensure maximum surface contact and heat transfer. The pipes and absorber plate are enclosed in an insulated metal or wooden box with a sheet of glazing material, either glass or plastic on the front to protect the enclosed absorber plate and create an insulating air space.  **Working** Sunlight passes through the glazing and strikes the absorber plate, which heats up, changing solar energy into heat energy. The heat is transferred to liquid passing through pipes attached to the absorber plate. Absorber plates are commonly painted with "selective coatings," which absorb and retain heat better than ordinary black paint. Absorber plates are usually made of metal—typically copper or aluminum—because the	2 2

		metal is a good heat conductor. Copper is more expensive, but is a better conductor and less prone to corrosion than aluminum. In locations with average available solar energy, flat plate collectors are sized approximately one-half- to one-square foot per gallon of one-day's hot water use.	
	e)	**Given Data** Heater Capacity = 5 MW CV of oil = 10,500 Kcal/kg = 43963.5 KJ/kg Heater produces energy of 5 MW = 5 MJ/s = 5000 KJ/s Oil required = Heater Capacity /CV of oil = 5000/43963.5 = 0.1137 Kg/s = 6.823 kg/min = 409.43 kg/hr	4
5		**Attempt any two of the following**	**12**
	a)	**Income tax** An **income tax** is a tax imposed on individuals or entities (taxpayers) that varies with respective income or profits (taxable income). Income tax generally is computed as the product of a tax rate times taxable income. Taxation rates may vary by type or characteristics of the taxpayer. The tax rate may increase as taxable income increases (referred to as graduated or progressive rates). The tax imposed on companies is usually known as corporate tax and is levied at a flat rate. However, individuals are taxed at various rates according to the slab in which they fall. Further, the partnership firms are also taxed at flat rate. Most jurisdictions exempt locally organized charitable organizations from tax. Capital gains may be taxed at different rates than other income. Credits of various sorts may be allowed that reduce tax. Some jurisdictions impose the higher of an income tax or a tax on an alternative base or measure of income. Taxable income of taxpayers resident in the jurisdiction is generally total income less income producing expenses and other deductions. Generally, only net gain from sale of property, including goods held for sale, is included in income. Income of a corporation's shareholders usually includes distributions of profits from the corporation. Deductions typically include all income producing or business expenses including an allowance for	3

		recovery of costs of business assets. Many jurisdictions allow notional deductions for individuals, and may allow deduction of some personal expenses. Most jurisdictions either do not tax income earned outside the jurisdiction or allow a credit for taxes paid to other jurisdictions on such income. Nonresidents are taxed only on certain types of income from sources within the jurisdictions, with few exceptions. **Excise tax** An **excise** or **excise tax** is any duty on manufactured goods which is levied at the moment of manufacture, rather than at sale. Excises are often associated with customs duties (which are levied on pre-existing goods when they cross a designated border in a specific direction); customs are levied on goods which come into existence – as taxable items – at the *border*, while excise is levied on goods which came into existence *inland*. Although sometimes referred to as a *tax*, excise is specifically a *duty*; *tax* is technically a levy on an individual (or more accurately, the assessment of what that amount might be), while duty is a levy on particular goods. An excise is considered an indirect tax, meaning that the producer or seller who pays the levy to the government is expected to try to recover their loss by raising the price paid by the eventual buyer of the goods. Excises are typically imposed in addition to an indirect tax such as a sales tax or value-added tax (VAT). Typically, an excise is distinguished from a sales tax or VAT in three ways: 1. an excise is typically a per unit tax, costing a specific amount for a volume or unit of the item purchased, whereas a sales tax or value-added tax is an *ad valorem* tax and proportional to the price of the goods, 2. an excise typically applies to a narrow range of products, and 3. an excise is typically heavier, accounting for a higher fraction of the retail price of the targeted products.	3
	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	3

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 supplied will be Q2 and the price will be P2, and so on.

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		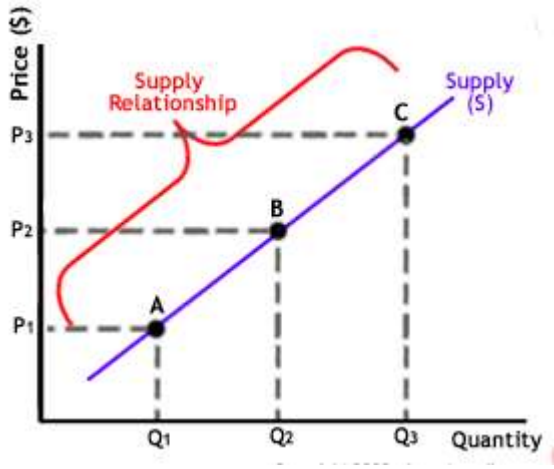	
	c)	**Given Data** Money borrowed = P =: 2 lakhs Interest rate= i = 3 % (monthly) = 36% yearly Period = n = 2 yrs Simple interest for 2 years = (P x i x n)/100 = (200000 x 36 x 2) /100 = 144000 Total amount payable A= 200000+144000 = 344000 For compounded interest $A = P (1+ i/t)^{nt}$ Where A = Amount payable P = Principle amount n = no of years (loan term) t = No of times interest rate is compounded per year $A = 200000 (1 + 0.36/12)^{12x2}$ A = 406558	2 4

6		Attempt any two of the following	12
	a)	**Cost** The term 'cost' means the amount of expenses [actual or notional] incurred on or attributable to specified thing or activity. As per Institute of cost and work accounts (ICWA) India, Cost is 'measurement in monetary terms of the amount of resources used for the purpose of production of goods or rendering services. To get the results we make efforts. Efforts constitute cost of getting the results. It can be expressed in terms of money; it means the amount of expenses incurred on or attributable to some specific thing or activity. **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 obayined. **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. **Direct Costs** Direct costs can be defined as costs which can be accurately traced to a cost object with little effort. Cost object may be a product, a department, a project, etc. Direct costs typically benefit a single cost object therefore the classification of any cost either as direct or indirect is done by taking the cost object into perspective. A particular cost may	1 1 1 1 1

		be direct cost for one cost object but indirect cost for another cost object. Most direct costs are variable but this may not always be the case. For example, the salary of a supervisor for a month who has only supervised the construction of a single building is a direct fixed cost incurred on the building. Examples: Cost of gravel, sand, cement and wages incurred on production of concrete. **Indirect Costs** Costs which cannot be accurately attributed to specific cost objects are called indirect costs. These typically benefit multiple cost objects and it is impracticable to accurately trace them to individual products, activities or departments etc. Examples: Cost of depreciation, insurance, power, salaries of supervisors incurred in a concrete plant.	1
	b)	**Interest** Interest is payment from a borrower or deposit-taking financial institution to a lender or depositor of an amount above repayment of the principal sum (i.e., the amount borrowed), at a particular rate. It is distinct from a fee which the borrower may pay the lender or some third party. It is also distinct from dividend which is paid by a company to its shareholders (owners) from its profit or reserve, but not at a particular rate decided beforehand, rather on a pro rata basis as a share in the reward gained by risk taking entrepreneurs when the revenue earned exceeds the total costs. **Types of interest** **Simple interest** Simple interest is calculated only on the principal amount, or on that portion of the principal amount that remains. It excludes the effect of compounding. Simple interest can be applied over a time period other than a year, e.g., every month. Calculations can be done using formula $A = P (1 + i n)$ Where A = amount payable P = Principle amount	1 2

		i = interest rate n = number of years amount borrowed **Compounded interest** Compound interest is the addition of interest to the principal sum of a loan or deposit, or in other words, interest on interest. It is the result of reinvesting interest, rather than paying it out, so that interest in the next period is then earned on the principal sum plus previously accumulated interest. Compound interest is standard in finance and economics. Compound interest may be contrasted with simple interest, where interest is not added to the principal, so there is no compounding. The simple annual interest rate is the interest amount per period, multiplied by the number of periods per year. It is calculated by $A = P (1+ i/t)^{nt}$ Where A = Amount payable P = Principle amount n = no of years (loan term) t = No of times interest rate is compounded per year	3
	c)	**Given data** Cost of heat exchanger in India = Rs. 50 lakh Salvage value = 5 lakh Life of HE = 10 yrs Cost of imported HE = Rs. 150 lakh Salvage value = 40 lakh Life of He = 20 yrs Interest rate = 8% Capitalized cost K $K = Co. + \frac{C_R}{(1+i)^n - 1}$	1 1 1

		For HE fabricated in India CO = 50 lakh, CR = 45 lakh, n = 10 yrs, i = 0.08 $K = 50 + (45/((1 +0.08)^{10} -1) = 88.23$ lakhs For imported HE $K = 150 + (110/((1+0.08)^{20} -1) = 180$ lakhs As capitalization cost of fabricated heat exchanger is lower it cheaper option.	1 1 1