



WINTER – 2022 EXAMINATION

Subject Name: Plant Economics and Energy Management

Model Answer

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.
- 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		Answer any five	10
1	a	Energy Energy is ability to do work. Energy is the quantitative property that is transferred to a body or to a physical system, recognizable in the performance of work and in the form of heat and light.	2 marks
1	b	Renewable energy sources 1. Solar energy 2. Wind energy 3. Hydropower 4. Biogas 5. Heat from biomass 6. Tidal Energy 7. Wave energy 8. Geothermal energy	½ mark each for any four



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1	c	<p>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</p> <p>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</p>	1 mark 1 mark
1	d	<p>Types of Markets</p> <ol style="list-style-type: none">1. Perfect completion2. Monopoly3. Oligopoly4. Monopolistic Completion5. Monopsony	1 mark each for any two types
1	e	<p>Cost</p> <p>The term ‘cost’ means the amount of expenses (actual or notional) incurred on or attributable to specified thing or activity.</p> <p>Cost is the expenditure required to create and sell products and services, or to acquire assets.</p>	2 marks
1	f	<p>Interest</p> <p>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</p>	2 marks
1	g	<p>Instruments used for energy audit (four)</p> <ol style="list-style-type: none">1. Power analyzer2. IR thermometer3. Lux meter4. Tachometer5. Anemometer6. IR camera7. Leak detector8. Combustion gas analyzer	½ mark each for any four

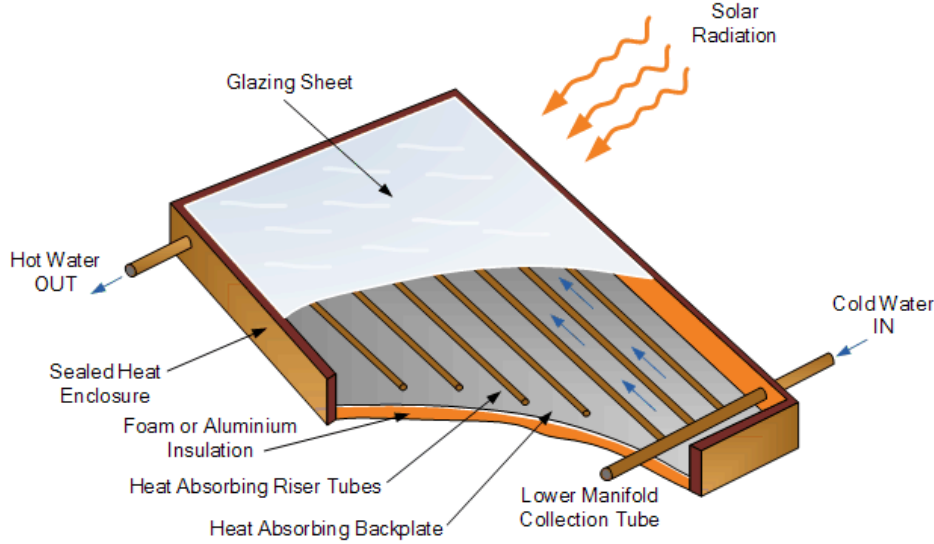
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2		Answer any four	12
2	a	<p>Given Data</p> <p>Heat produced in heater = $Q = 500000$ kJ/hr</p> <p>Calorific value of Coal = $CV = 25000$ kJ/kg</p> <p>Amount of coal required per hour = $Q/CV = 500000/25000 = 20$ kg/hr</p> <p>Amount of coal required per day = $20 \times 24 = 480$ kg/day</p>	4 marks
2	b	<p>Solar Flat Plate Collector</p> 	4 marks
2	c	<p>Strategies for Energy Security</p> <ul style="list-style-type: none"> • Diversification of the sources of Imports • Discovering and Exploiting own Energy Resources • Reducing domestic energy demand • Exploiting Shale and Its Potential in India • Distributed energy generation • Building Strategic Reserves • Expansion of Renewable Energy Consumption • Increasing Domestic Production of Coal • Promoting Energy Conservation Activities 	1 mark each for any four
2	d	Simple interest	



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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

i = interest rate

n = number of years amount borrowed

Compound 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

Example

If simple interest is charged at 5% on a 10,000 loan that is taken out for three years, then the total amount of interest payable by the borrower is calculated as $10,000 \times 0.05 \times 3 = 1,500$.

Interest on this loan is payable at 500 annually, or 1,500 over the three-year loan term.

If it is compounded annually (t = 1) then

2 marks

2 marks



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$$\text{Interest} = 10,000((1+0.05)^3 - 1) = 10,000(1.157625 - 1) = 1,576.25$$

3 Answer any four

12

3 a Clean energy technologies

Solar energy

Solar energy is the heat and light radiated from the Sun that powers Earth's climate and supports life. Solar technologies allow controlled use of this energy resource. Solar power is a synonym of solar energy or refers specifically to the conversion of sunlight into electricity by photovoltaics, concentrating solar thermal devices and various experimental technologies.

The controlled use of solar energy is an important consideration in building design. Thermal mass is used to conserve the heat that sunshine delivers to all buildings. Daylighting techniques optimize the use of light in buildings. Solar water heaters heat swimming pools and provide domestic hot water. In agriculture, greenhouses grow specialty crops and photovoltaic-powered pumps provide water for grazing animals. Evaporation ponds find applications in the commercial and industrial sectors where they are used to harvest salt and clean waste streams of contaminants.

Wind Energy

Among the different renewable energy sources, wind energy is currently making a significant contribution to the installed capacity of power generation, and is emerging as a competitive option. The programme covers research and development, survey and assessment of wind resources, implementation of demonstration and private sector projects and promotional policies. As a result, India, with an installed capacity of about 3000 MW, ranks fifth in the world after Germany, USA, Spain and Denmark in wind power generation.

Note: Any other technologies can also be given marks.

2 marks each for any 2 technologies

3 b Direct Current

Direct current (DC) is an electric current that is uni-directional, so the flow of charge is always in the same direction. As opposed to alternating current, the direction and amperage of direct currents do not change. It is used in many household electronics and in all devices

1 mark each for 4 definitions & unit



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that use batteries.

Unit: Ampere

Alternating Current

Alternating Current (AC) is a type of electrical current, in which the direction of the flow of electrons switches back and forth at regular intervals or cycles. Current flowing in power lines and normal household electricity that comes from a wall outlet is alternating current.

Unit: Ampere

Specific heat

The quantity of heat required to raise the temperature of one gram of a substance by one Celsius degree. The units of specific heat are usually calories or joules per gram per Celsius degree. For example, the specific heat of water is 1 calorie (or 4.186 joules) per gram per Celsius degree.

Unit: kJ/kgK

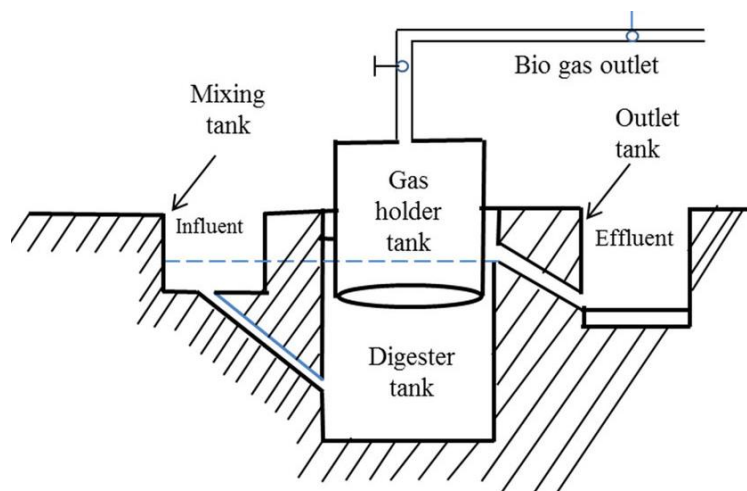
Latent heat

Latent heat is defined as the heat or energy that is absorbed or released during a phase change of a substance. It could either be from a gas to a liquid or liquid to solid and vice versa.

Unit: kJ/kg

3 c **Floating roof biogas plant**

4 marks



3 d **Features Energy Conservation act**

1 mark each
for any four



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		<p>This act gives the power to the central government and in some cases, the state also gets the power to:</p> <ul style="list-style-type: none">• Fix the energy usage standards for specific appliances and equipment.• Give direction that there should be a mandatory display of labels specific equipment and appliances.• Stop the building, import, and sale of the items which are not to the standards.• Inform energy concentrated businesses, different foundations, and business structures as assigned customers• Set up and recommend energy utilization standards and guidelines for assigned buyers• Prescribe or make changes in Energy Conservation Building Codes (ECBC) to local conditions for energy conservation and efficient use of energy in a new commercial building with a contract load of 500 kW.• Make and provide Central and State Energy Conservation Fund	points
4		Answer any four	12
4	a	<p>Coal as energy source</p> <p>Coal is one of the most important primary fossil fuels, a solid carbon-rich material that is usually brown or black and most often occurs in stratified sedimentary deposits. Coal is defined as having more than 50 percent by weight (or 70 percent by volume) carbonaceous matter produced by the compaction and hardening of altered plant remains—namely, peat deposits. Different varieties of coal arise because of differences in the kinds of plant material (coal type), degree of coalification (coal rank), and range of impurities (coal grade).</p> <p>Coal is an abundant natural resource that can be used as a source of energy, as a chemical source from which numerous synthetic compounds (e.g., dyes, oils, waxes, pharmaceuticals, and pesticides) can be derived, and in the production of coke for metallurgical processes. Coal is a major source of energy in the production of electrical power using steam generation. In addition, gasification and liquefaction of coal produce gaseous and liquid fuels that can be easily transported (e.g., by pipeline) and conveniently stored in tanks. After the tremendous rise in coal use in the early 2000s, which was</p>	4 marks



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primarily driven by the growth of China's economy, coal use worldwide peaked in 2012. Since then coal use has experienced a steady decline, offset largely by increases in natural gas use.

Petroleum as energy source

Petroleum, also called crude oil, is a naturally occurring liquid found beneath the earth's surface that can be refined into fuel. A fossil fuel, petroleum is created by the decomposition of organic matter over time and used as fuel to power vehicles, heating units, and machines, and can be converted into plastics.

The separation of petroleum yields many useful products. These products are useful for transportation, fuel oil for heating and electricity generation, and asphalt. Products include gasoline, jet fuel (or kerosene), propane, petroleum coke, bitumen, plastics and waxes. A majority of petroleum is turned into an energy source. Other than gasoline, petroleum can also be used to make heating oil, diesel fuel, jet fuel, and propane. These fuels are driver of economy. Hence petroleum plays very vital role world economy

Natural gas as energy source

Natural gas is a fossil fuel and non-renewable resource that is formed when layers of organic matter (primarily marine microorganisms) decompose under anaerobic conditions and are subjected to intense heat and pressure underground over millions of years. The energy that the decayed organisms originally obtained from the sun via photosynthesis is stored as chemical energy within the molecules of methane and other hydrocarbons.

Natural gas is often described as "clean burning" because it produces fewer undesirable by-products per unit energy than coal or petroleum. Like all fossil fuels, its combustion emits carbon dioxide, but at about half the rate of coal per kilowatt hour of electricity generated. It is also more energy efficient. On average, a typical coal-burning power plant in 2013 was about 33% efficient in converting heat energy into electrical power. A gas-fired plant was about 42% efficient. And in natural gas combined-cycle power plants in which waste heat from a natural gas turbine is used to power a steam turbine generation may be as much as 60% efficient. It is also used as transportation fuel.

4 b **Horizontal axis wind turbine (HAWT)**

HAWTs work predominantly on lift principle. As the wind stream interacts with the rotor

2 marks

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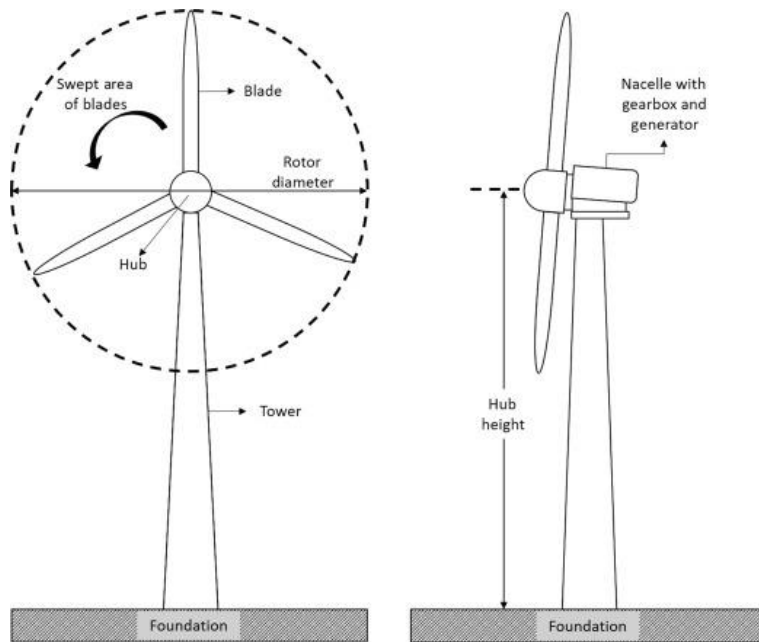
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blades, lift force is generated as explained in the previous section, causing the rotor to rotate. The rotational speed varies with the design features and the size of the rotor.

The construction of a horizontal axis wind turbine can be done with different components. So the horizontal axis wind turbine components mainly include foundation, nacelle, generator, tower, and rotor blades.

Once the wind blows, a wind turbine changes the kinetic energy from the motion of the wind into mechanical through the revolution of the rotor. After that, this converted energy can be transmitted through the shaft & the gear train toward the generator. Further, this generator converts the energy from mechanical to electrical to generate electricity.

The wind flows on both faces of the airfoil-shaped blade although flows faster on the upper face of the airfoil to create a low-pressure region on the airfoil. The pressure difference between both the top & bottom surfaces results within the aerodynamic lift.



2 marks

4

c

Hydro Power Plant

4 marks



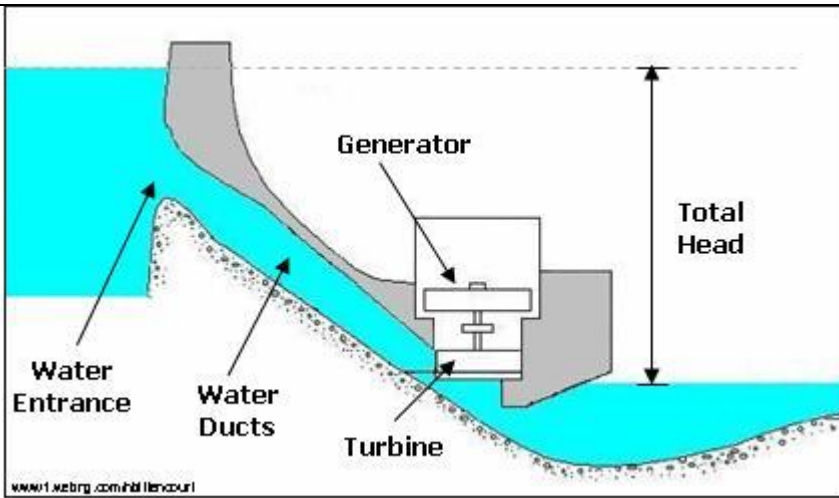
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d **Detailed Energy Audit**

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.

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

4 marks

4

e **Energy conservation objectives:(any four)**

Broadly energy conservation program initiated at micro or macro level will have the following objectives of manufactured goods her lower process or increased) availability and profitability, and in consequence raise the standard of living both of the workers in

4 marks



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		industry and of those who buy the products a) To reduce imports of energy and reduce the drain on foreign exchange. b) To 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 sulphur dioxide dust grit or as coal mine discard for example d) Thus reducing the costs that pollution incurs either directly a damage or as needing special insures to combat it once pollutants are produced., e) Generally to relieve shortage and improve development	
5		Answer any two	12
5	a	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).	4 marks



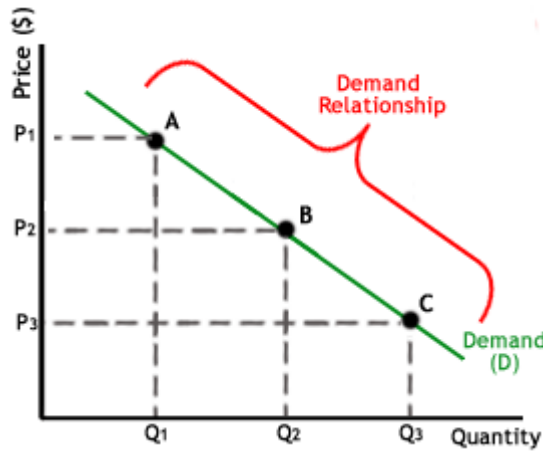
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2 Marks

5

b

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 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

3 Marks



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		<p>jurisdictions on such income. Nonresidents are taxed only on certain types of income from sources within the jurisdictions, with few exceptions.</p> <p>Excise tax</p> <p>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 <i>border</i>, while excise is levied on goods which came into existence <i>inland</i>.</p> <p>Although sometimes referred to as a <i>tax</i>, excise is specifically a <i>duty</i>; <i>tax</i> 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).</p>	3 Marks
5	c	<p>Factors affecting cost estimation</p> <p>1) Labor Wage Rates: Labor wages varies place to place. So, local wage rate should be considered in calculation. If the project has to be started after several months of estimating the project cost, the probable variation in wage rates has to be considered in the calculation.</p> <p>2) Inflation Factor: A construction project can continue for years before completion. During the construction period, the cost of materials, tools, labors, equipments etc. may vary from time to time. These variation in the prices should be considered during cost estimation process.</p> <p>3) Project Schedule: Duration of construction project is affects the cost. Increase in project duration can increase the construction project cost due to increase in indirect costs, while reduction in construction cost also increases the project cost due to increase in direct costs. Therefore, construction project schedules also need to be considered during project cost estimation.</p> <p>4) Quality of Plans & Specifications: A good quality construction plans and specifications reduces the construction time by proper execution at site without delay. Any vague wording or poorly drawn plan not only causes confusion, but places doubt in the</p>	1 mark each for any six points



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contractor's mind which generally results in a higher construction cost.

5) Reputation of Engineer: Smooth running of construction is vital for project to complete in time. The cost of projects will be higher with sound construction professional reputation. If a contractor is comfortable working with a particular engineer, or engineering firm, the project runs smoother and therefore is more cost-effective.

6) Regulatory Requirements: Approvals from regulatory agencies can sometimes be costly. These costs also need to be considered during cost estimate.

7) Insurance Requirements: Cost estimation for construction projects should also need to consider costs of insurance for various tools, equipments, construction workers etc. General insurance requirements, such as performance bond, payment bond and contractors general liability are normal costs of construction projects. In some special projects, there can be additional requirements which may have additional costs.

8) Size and Type of Project: For a large project, there can be high demand for workforce. For such a requirements, local workmen may not be sufficient and workmen from different regions need be called. These may incur extra costs such projects and also for the type of construction project where specialized workforce is required.

9) Location: When a location of construction project is far away from available resources, it increases the project cost

10) Contingency: It is always advisable to add at least 10% contingency towards the total project costs for unforeseen costs and inflation.

6 Answer any two

12

6 a Perfect Competition

Perfect competition is a market system characterized by many different buyers and sellers. In the classic theoretical definition of perfect competition, there are an infinite number of buyers and sellers. With so many market players, it is impossible for any one participant to alter the prevailing price in the market. If they attempt to do so, buyers and sellers have infinite alternatives to pursue.

The main features of perfect competition are as follows:

- Many Buyers and Sellers
- Homogeneity
- Free Entry and Exit

3 marks



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- Perfect Knowledge
- Mobility of Factors of Production
- Absence of Artificial Restrictions
- Uniform Price

Example : There is no perfect competition market.

Monopoly

A monopoly is the exact opposite form of market system as perfect competition. In a pure monopoly, there is only one producer of a particular good or service, and generally no reasonable substitute. In such a market system, the monopolist is able to charge whatever price they wish due to the absence of competition, but their overall revenue will be limited by the ability or willingness of customers to pay their price.

Features of Monopoly Market

Maximise profit: It is an important reason why a company wants to be in a monopoly market. The company strives to generate and secure not only the revenue but also to maximise the profit.

Price maker: The monopoly players have the authority to fix and plan the price of goods. In this market, the firm has the sole right to influence the market rate and has the pricing power. Here, the price is modified according to the demand and supply of goods in the market.

High competition: A monopoly market has high barriers for new players or participants to enter. Sometimes, high competition makes it difficult for participants of the monopoly market to make less profits.

Example : Indian Railways, BCCI, Microsoft

3 marks

6

b

Straight line depreciation

In straight line depreciation method, cost of a fixed asset is reduced uniformly over the useful life of the asset. Since depreciation expense charged to income statement in each period is the same, the carrying amount of the asset on balance sheet declines in a straight line. Due to its simplicity, straight line method of depreciation is the most commonly used depreciation method. Accounting principles require companies to depreciate its fixed assets using method that best reflects the pattern in which the assets are being used. While the

4 marks



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straight-line method is appropriate in many situations, some fixed assets lose more value in initial years. In such situations other depreciation methods are more appropriate.

Straight line depreciation method can be calculated using following formula:

$$\text{Depreciation per annum} = (\text{Cost of the Asset} - \text{Salvage Cost}) \times \text{Depreciation Rate}$$

$$\text{Depreciation per annum} = \frac{(\text{Cost of the assets} - \text{Salvage Cost})}{\text{Useful Life}}$$

Suppose a business has bought a machine for 10,000. They have estimated the useful life of the machine to be 8 years with a salvage value of 2,000.

Now, as per the straight line method of depreciation:

- Cost of the asset = 10,000
- Salvage Value = 2000
- Total Depreciation Cost = Cost of asset – Salvage Value = 10000 – 2000 = \$ 8000
- Useful life of the asset = 8 years

Thus, annual depreciation cost = (Cost of asset – Salvage Cost)/Useful Life = 8000/8 = 1000

Hence, the Company will depreciate the machine by 1000 every year for 8 years.

(Amount is in INR)

2 marks

c **Advantages of payout period**

Simple to use and easy to understand

This is among the most significant advantages of the payback period. The method needs very few inputs and is relatively easier to calculate than other capital budgeting methods.

All that you need to calculate the payback period is the project's initial cost and annual cash flows. Though other methods also use the same inputs, they need more assumptions as well. For instance, the cost of capital, which other methods use, requires managers to make several assumptions.

Quick solution

Since the payback period is easy to calculate and need fewer inputs, managers are quickly able to calculate the payback period of the projects. This helps the managers to make quick decisions, something that is very important for the companies with limited resources.

Preference for liquidity

Payback period is crucial information that no other capital budgeting method reveals.

3 mark for
advantaged
and 3 marks
for
disadvantage



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Usually, a project with a shorter payback period also has a lower risk. Such information is extremely crucial for the small businesses with limited resources. Small businesses need to quickly recover their cost so as to reinvest it in other opportunities.

Useful in case of uncertainty

The payback method is very useful in the industries that are uncertain or witness rapid technological changes. Such uncertainty makes it difficult to project the future annual cash inflows. Thus, using and undertaking projects with short PBP helps in reducing the chances of a loss through obsolescence.

Disadvantages of payback period

Not all cash flows covered

The payback method considers the cash flows only till the time the initial investment is recovered. It fails to consider the cash flows that come in the subsequent years. Such a limited view of the cash flows might force you to overlook a project that could generate lucrative cash flows in their later years.

Not realistic

The payback method is so simple that it does not consider normal business scenarios. Usually, capital investments are not just one-time investments. Rather such projects need further investments in the following years as well. Also, projects usually have irregular cash inflows.

Ignores profitability

A project with a shorter payback period is no guarantee that it will be profitable. What if the cash flows from the project stop at the payback period, or reduces after the payback period. In both the cases, the project would become unviable after the payback period ends.