SUMMER-16 EXAMINATION

Model Answer

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.	Answer	marks	Total marks
1	Attempt any 5		20
1.a	**Unit operations involved in alcohol manufacturing:** 1. Distillation 2. Filtration 3. Mixing **4.** Evaporation	1 mark each	4
1.b	**Nutritional requirement of yeast:** Yeast require carbon source as it can not do photosynthesis. They also required vitamins, minerals and organic nitrogen source. The micronutrient are the source of carbon, nitrogen, phosphate and sulphate	4	4
1.c	**Sterile air in pre fermenter:** In addition to contaminants such as dust, pollen, water or oil aerosols and hydrocarbon or other vapours, compressed air contains bacteria with the potential to spoil product. Sanitary applications in the food, beverage, pharmaceutical and electronic industries require compressed air that is free of all the above contaminants. Sterile means free from live bacteria or other microorganisms. Most fermentations are operated under high aeration and the air supplied to the fermentor must be sterilized. Aerobic fermentation process require significant quantities of sterile air. The sterilization of air in the strict bacteriological sense means the complete elimination of all viable microorganisms.	4	4
1.d	**BOD:** It is the amount of oxygen required to degrade organic waste present in water by purely biological means. The biological oxygen demand, ie, BOD in	2	4

	wastewater, is a measure of the quantity of bio-organic substances in wastewater. These can be in the form of fat, oils, carbohydrates and proteins. BOD helps determine the quantum of organic chemicals contained in wastewater that are synthetic and biodegradable **COD: -** It is the amount of oxygen required to degrade organic waste present in water by purely chemical means. COD can help gauge the quantum of both biodegradable and non-biodegradable organics. It is quick method to determine strength of waste in water.	2	
1.e	**Manufacture of rum:** Rum is an alcoholic distillate from the fermented juice of sugar cane, sugar cane syrup, sugarcane molasses or other sugarcane byproducts. Cane juice or diluted molasses mash may be allowed to ferment spontaneously using yeast present naturally in the feedstock. To attempt a more controlled fermentation in production of heavy rums, a pure culture of yeast may be used together with a pure bacterial culture. In light rum production, the emphasis is generally on maintaining clean, rapid fermentation to minimize development of undesirable congeners and to maximize fermentation efficiency. Pure cultures of yeast may be propagated. These may be accompanied by the use of antibiotics such as pencillin or bactericides such as chlorine dioxide.pH is lowered to 3.7 to reduce bacterial growth and upto 90% of the yeast volume is used to inoculate a fermenter. The prefermenter is refilled with mash to repeat the process several times.	4	4
1.f	**(i)Yeast acidification:** Yeast can grow at low pH, but 4.6 is generally considered the level that will prevent the growth and toxin production for pathogens. pH is considered primarily a means of growth inhibition and not a	2	4

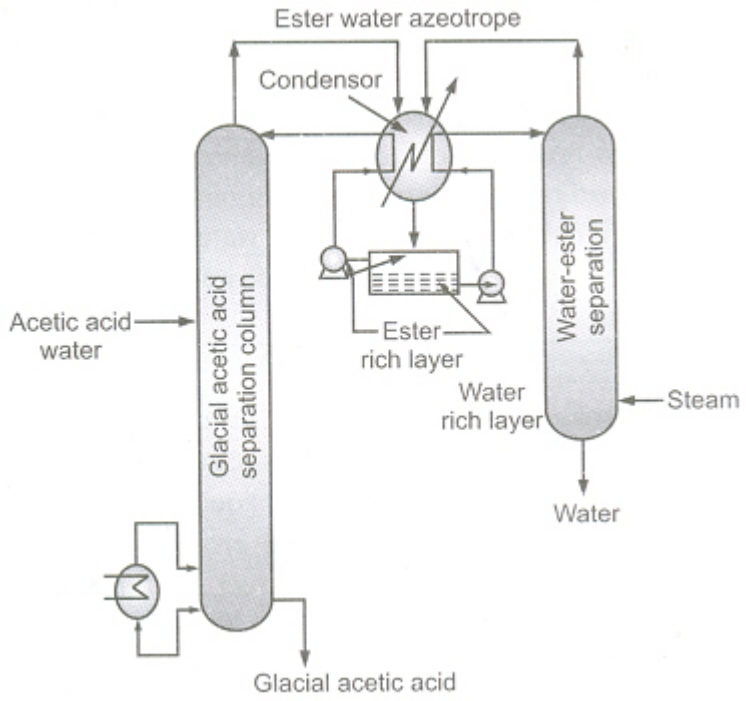
	method for destruction of existing pathogens. A pH of 4.6 is used as a divider between high acid and low acid foods. Some foods that are naturally low acid are processed in a way that makes them a high acid food. This is called acidification. Acidification is the direct addition of acid to a low acid food (pH less than 4.6). These foods are called acidified foods. There are a variety of organic acids that are used- acetic, lactic or citric. Selection of acid depends on the desired attributes of the finished products. Acidification (ii) **Significance:** 1. To improve the quality of food.(desired taste, texture) 2. helps in non refrigerated storage. 3. helps in preventing the growth and toxin production for pathogens.	2	
1.g	**Biological treatment of effluent from alcohol industry:** The most commonly used conventional units for reducing the organic matter in effluent makes use of biological oxidation. The most commonly used conventional units for biological oxidation are activated sludge and its modifications or trickling filter. The key to the successful operation of biological –oxidation units is the maintenance of adequate food, microorganisms, aerobic conditions and a favorable environment for the organisms to grow in at the cost of organic matter. The conventional activated sludge process consist of primary sedimentation treatment to remove organics that can be settled out, biological oxidation/ aeration, settling of activated sludge and returning part of it to be mixed with the raw waste and suitable disposal of excess sludge produced as well as disinfection of the treated liquid effluent produced.	4	4

2	Attempt any 4		16
2.a	**Distillation in alcohol manufacturing:** Yeast cannot survive in high levels of alcohol, so to create stronger spirits an additional process, distillation, is required. Fermented drinks are distilled to create vodka, rum and other spirits. Distillation relies on ethanol having a lower boiling point than water. When the fermented drink is heated the ethanol vaporises at 78.5 degrees and the water is left behind (water boils or vaporises at 100 degrees). The ethanol gas is caught and cooled so it condenses into a stronger concentration of ethanol liquid.	4	4
2.b	**Nutrients required for yeast:** 1. Glucose 2. Fructose 3. sucrose 4. Amino acids 5. Ammonia 6. Peptides 7. Organic phosphates 8. Inorganic phosphates 9. Inorganic sulphur compounds 10. Organic sulphur compounds	½ mark each for any 8	4
2 c	**Material of construction of yeast vessel:** 1.Plastics: Light, inexpensive, not resistant to heat and chemicals, low thermal conductivity. 2. Ceramics: Inert, easily worked, inexpensive, fragile and only suitable for small scale domestic brewing.	1 mark each for any 4	4

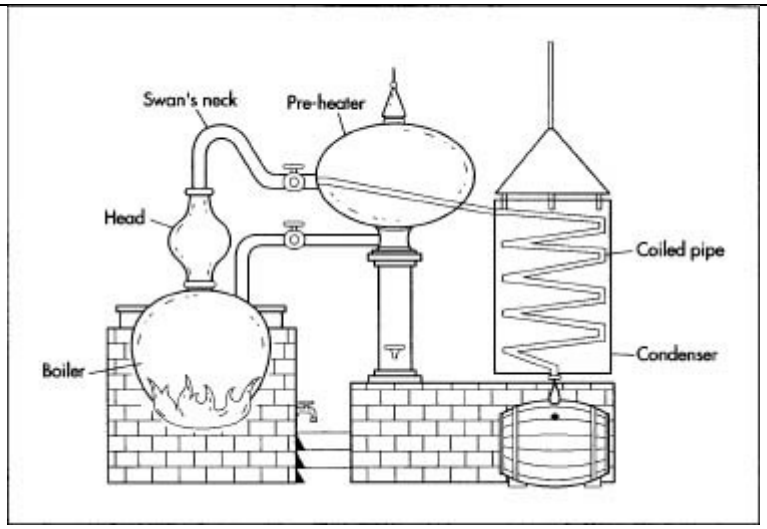
	3. Stainless steel (most preferred) : Strong, very durable, expensive, excellent cleaning properties, corrosion resistant, high thermal conductivity. 4. copper: strong, easily cleaned, very expensive, very high thermal conductivity. 5. Concrete: Durable, can be formed in to any shape, relatively heavy but can be used for large vessels, requires inert lining material. 6. Aluminium: Light, durable, easily worked, can be used as lining material or as main fabric of vessels, susceptible to attack by alkalies, subjected to electro chemical corrosion.		
2 d	**Manufacture of malt alcohol:** The process consist of seven steps: mashing, lautering, boiling, fermentation, conditioning, filtering and packaging. Mashing: It is the process where all the ingredients are mixed with water and heated to a pre specified temperature. Lautering: It is the process of separating the wort extracts from the spent grain after the mashing. Boiling: It is the stage where the filtered wort extracts are heated to a certain temperature to maintain the sterility which later helps in preventing the extract from infections. Fermentation: It commences as soon as yeast is added to the cooled wort. Yeast act as a catalyst in metabolizing the malt into alcohol and carbon dioxide. Conditioning: it is the stage where the beer is cooled down to freezing temperature. Filtering: It is the process of stabilizing the beer flavor and filters out any remaining hops, grain particles and yeast in the beer. Packaging: It is the process of filling the beer into the containers such as	3	4

	bottles, cans etc.		
2 e	(i) **Toxological Effects of effluent from alcohol industry:** 1.Effluent from alcohol industry causes severe land pollution(foul smell and dark colour) 2. Distillery effluent causes decrease in dissolved oxygen and prove dangerous to aquatic life. 3.If the effluent from the alcohol industry is used for irrigation, high BOD water results in crop failure 4.Seapage of coloured liquids can adversely affect ground water as well as land quality. 5. Soil condition will be deteriorated in course of time.	1 mark each for any 4	4
2.f	**Enzyme dosing:** Ethanol production in the dry grind ethanol industry is done by converting the starch in corn to ethanol using enzymes and yeast. Enzyme dosing is required to convert starch to glucose and glucose to ethanol. Optimization the enzyme dose for the production of ethanol and sugar during the simultaneous saccharification and fermentation (SSF) process is required. Experimentation is required to decide the quantity of enzymes required. Samples can be taken at 2, 4, 6, 8, 10, 12, 24, 48, and 72 h from the start of SSF. Samples were analyzed using high-pressure liquid chromatography (HPLC) and near-infrared spectroscopy for the ethanol and sugar contents. Each treatment was replicated three times. Response surface methodology (RSM) was used for studying effects of treatment on the response and optimization of the SSF process.	4	4
3	Attempt any 4		16
3.a	**Azeotropic distillation :** An azeotrope is a liquid mixture with an equilibrium vapour of same	4	4

	composition as the liquid. The dew point and bubble point are identical at azeotropic composition and mixture vapourises at single temperature , so azeotropes are called constant boiling mixture. Azeotrope cannot be separated by distillation because the dew point and bubble point are identical. The constituents of binary azeotrope are separated completely by 1) Adding third component to the binary mixture 2) By changing system pressure. The third component added to the binary azeotrope usually form a low boiling azeotrope with one of the feed constituents and withdrawn as distillate. The third component added is called as entrainer or azeotrope breaker. The process of distillation where the third component is added to the binary azeotrope to effect the complete separation is called azeotropic distillation. In azeotropic distillation of acetic acid-water mixture, n butyl acetate is used as the entrainer. Addition of entrainer will result in the formation of a minimum boiling azeotrope with water. The azeotropic mixture therefore will be distilled over as vapour product from the high boiling acetic acid, which leaves as bottomproduct.		

	 **Example : ethanol-water mixture, acetic acid-water**		
3.b	**Affect of bacteria in fermentation process :** Fermentation bacteria are anaerobic, but use organic molecules as their final electron acceptor to produce fermentation end-products. *Streptococcus*, *Lactobacillus*, and *Bacillus*, for example, produce lactic acid, while *Escherichia* and *Salmonella* produce ethanol, lactic acid, succinic acid, acetic acid, CO_2, and H_2. Fermenting bacteria have characteristic sugar fermentation patterns, i.e., they can metabolize some sugars but not others. For example, *Neisseria meningitidis* ferments glucose and maltose, but not sucrose and lactose, while *Neisseria gonorrhoea* ferments glucose, but not maltose, sucrose or lactose. Such fermentation patterns can be used to identify and classify bacteria.	4	4
3.c	**Maintenance of yeast vessel:**	1 mark each	4

	1. All the lines to the vessels are flushed with water and steam sterilized. 2. Valve should be checked at regular intervals. 3. Gasket should be changed at regularly. 4. Filter insert is to be replaced every two years.		
3 d	**Manufacturing of brandy:** **Raw Materials** The raw materials used in brandy production are liquids that contain any form of sugar. Anything that will ferment can be distilled and turned into a brandy. Grapes, apples, blackberries, sugar cane, honey, milk, rice, wheat, corn, potatoes, and rye are all commonly fermented and distilled. Mass-produced brandy, other than having the same alcohol content, has very little in common with fine brandy. Instead of the painstaking double distillation in small batches, mass-produced brandies are made via fractional distillation in column stills. Column stills are sometimes called continuous stills as raw material is continuously poured into the top while the final product and wastes continuously come out of the side and bottom. 1. A column still is about 30-ft (9-m) high and contains a series of horizontal, hollow baffles that are interconnected. Hot wine is poured into the top of the column while steam is run through the hollow baffles; the steam and wine do not mix directly. The alcohol and other low boiling point liquids in the wine evaporate. The vapors rise while the non-alcoholic liquids fall. As the still is cooler at the top, the rising vapors eventually get to a part of the still where they will condense, each type of vapor at a temperature just above its own boiling point.	4	4



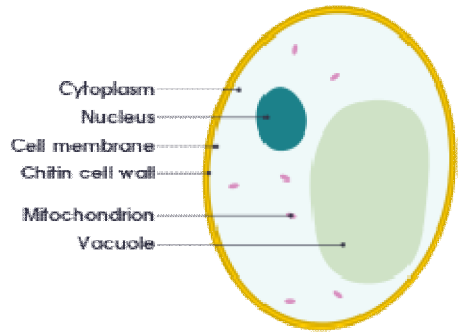
2. Once they have recondensed, the liquids begin to move downward in the still. As they fall, they boil again. This process of boiling and condensing, rising and falling, happens over and over again in the column. The various components of the wine fraction and collect in the column where the temperature is just below the boiling point of that component. This allows the ethyl alcohol condensate to be bled out of the column at the height where it collects. The resulting product is a pure spirit, colorless, odorless, and tasteless, with an alcohol content of about 96.5%. At 96.5% alcohol, it can be used to fuel automobiles. It can be diluted and called vodka or diluted and flavored with juniper berries and called gin.
3. Mass-produced brandies are also aged in oak casks and pick up some flavors from them. Like its fine counterpart, the brandies are blended, diluted to around 40% alcohol, and bottled.

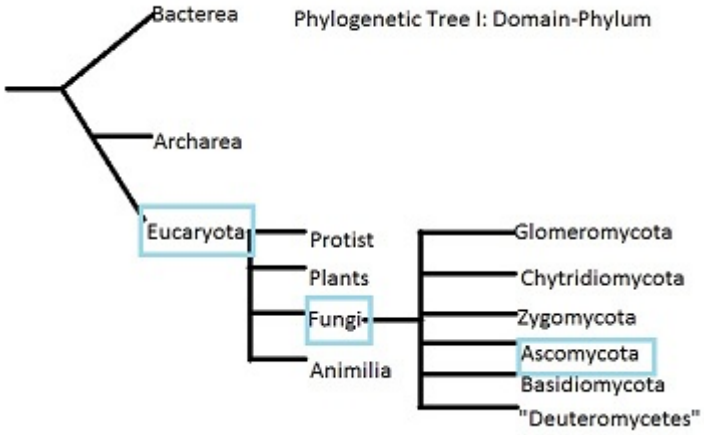
3 e	**Government stipulated conditions for alcohol industry wastewater:** Effluent standards: BOD-100mg / l for land disposal 30 mg / l for disposal in streams	1 mark each for any 4	4

	pH – between 5.5 and 9 Total dissolved solids: 2100 mg / l Oil and grease: less than 10 mg / l Sodium : < 60% Ammoniacal nitrogen: < 50 mg/l		
3 f	**Preparation of Yeast in laboratory** **Budding yeast life cycle** Yeast typically grows asexually by budding. A small bud which will become the daughter cell is formed on the parent (mother) cell, and enlarges with continued grow. As the daughter cell grows, the mother cell duplicates and then segregates its DNA. The nucleus divides and migrates into the daughter cell. Once the bud contains a nucleus and reaches a certain size it separates from the mother cell. The series of events that occur in a cell and lead to duplication and division are referred to as the cell cycle. The cell cycle consists of four distinct phases (G1, S, G2 and M) and is regulated similar to that of the cell cycle in larger eukaryotes. As long as adequate nutrients such as sugar, nitrogen and phosphate are present yeast cells will continue to divide asexually. Yeast cells can also reproduce sexually. Yeast cells exist as one of two different mating types, **a** cells and **alpha** cells. When cells of opposite mating types are mixed together in the lab or randomly come into contact in nature they can mate (conjugate). Before joining the cells change shape in a process called shmooing.. During conjugation the shmooing haploid cells first fuse and then their nuclei fuse, resulting in the formation of a diploid cell with two copies of each chromosome. Once formed, diploid cells can reproduce asexually by budding, similar to haploids. However, when diploid cells are starved of nutrients they undergo sporulation. During sporulation diploid cells undergo	4	4

	meiosis, a special form of cell division that reduces the number of chromosomes from two copies back to one copy. After meiosis the haploid nuclei produced in meiosis are packaged into four spores that contain modified cell walls, resulting in structures that are very resistant to environmental stress. These spores can survive long periods of time until conditions become more favorable, such as in the presence of improved nutrients, whereupon they are able to germinate and reproduce asexually. These different states, budding, conjugation and sporulation together make up the yeast life cycle. **Yeast growth and metabolism** When yeast cells are grown in rich carbon sources such as glucose they prefer to grow by fermentation. During fermentation glucose is converted into carbon dioxide and ethanol. Generally, fermentation occurs in the absence of oxygen, and is therefore anaerobic by nature. Even in the presence of oxygen yeast cells prefer to grow fermentatively and this is referred to as the Crabtree Effect after the biologist who discovered this preference. This form of growth is exploited in the making of bread, beer, wine and other alcoholic beverages. Although budding yeast cells prefer to grow by fermentation, when nutrients are limiting they are also able to grow by cellular respiration. During respiration cells convert glucose into carbon dioxide and water, consuming oxygen in the process, and resulting in the production of much larger amounts of energy in the form of ATP.		
4	Attempt any 4		16
4.a	**Process of pretreatment of enzyme** Firstly, there is a liquefaction process. A starch suspension containing 30-40% dry matter is first gelatinised and liquefied. By using heat-stable bacterial alpha amylase, 'maltodextrin' is obtained which contains mainly different	4	4

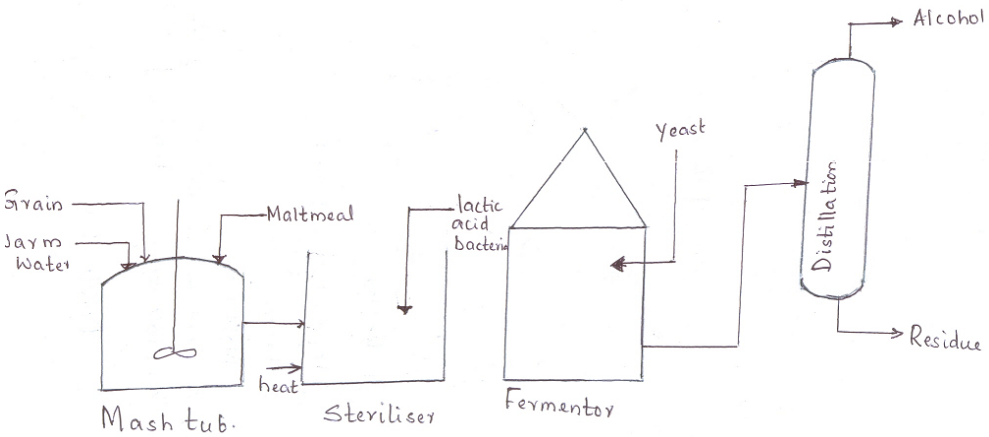
	oligosaccharides and dextrins. Maltodextrins are only slightly sweet and they usually undergo further conversion. In most starch conversion plants, starch liquefaction takes place in a jet-cooking process. The heat stable alpha amylase is added to the starch slurry after pH adjustment, and the slurry is pumped through a jet cooker. Live steam is injected here to raise the temperature to 105^{o}C, and the slurry is then passed through a series of holding tubes for 5-7 minutes, which is necessary to gelatinise the starch fully.Then the temperature of the partially liquefied starch is reduced to 90-100^{o}C by flashing, and the enzyme is allowed to react further at this temperature for 1-2 hours until the required DE (Dextrose Equivalent) is obtained		
4.b	**Evaporation Process in chemical industry:** Evaporation process is commonly used in food and fermentation industries to concentrate the feed or recover targeted products. Evaporation, in a technical sense, denotes the conversion of a liquid into a vapor for the purpose of separating it from another liquid of higher boiling point, or from a solid which is dissolved in it. In the great majority of cases, the liquid evaporated is water. If the liquid evaporated is to be recovered, the vapors are condensed, and the process then becomes one of Distillation. There are four general methods of evaporation: 1. Spontaneous evaporation in the open ail. 2. Evaporation by application of heat directly from a fire to the vessel containing the liquid. 3. Evaporation by indirect application of heat from the fire, as by means of steam, with or without pressure. 4. Evaporation under reduced pressure.	4	4

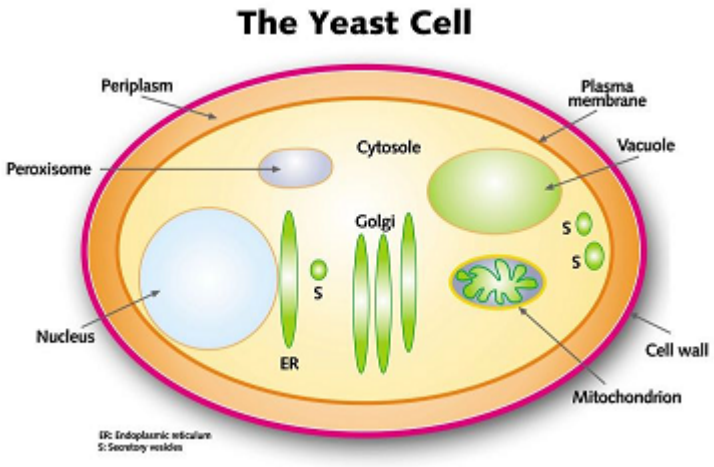
4.c	**Taxonomy of Yeast** Yeasts do not form a single taxonomic or phylogenetic grouping. The term "yeast" is often taken as a synonym for *Saccharomyces cerevisiae*, but the phylogenetic diversity of yeasts is shown by their placement in two separate phyla: the Ascomycota and the Basidiomycota. The budding yeasts ("true yeasts") are classified in the order Saccharomycetales.  **Scientific classification** **Domain:** Eukaryota **Kingdom**: Fungi **Phyla and Subphyla** Ascomycota • Saccharomycotina (true yeasts) • Taphrinomycotina o Schizosaccharomycetes (fission yeasts) Basidiomycota • Agaricomycotina o Tremellomycetes • Pucciniomycotina. o Microbotryomycetes	4	4

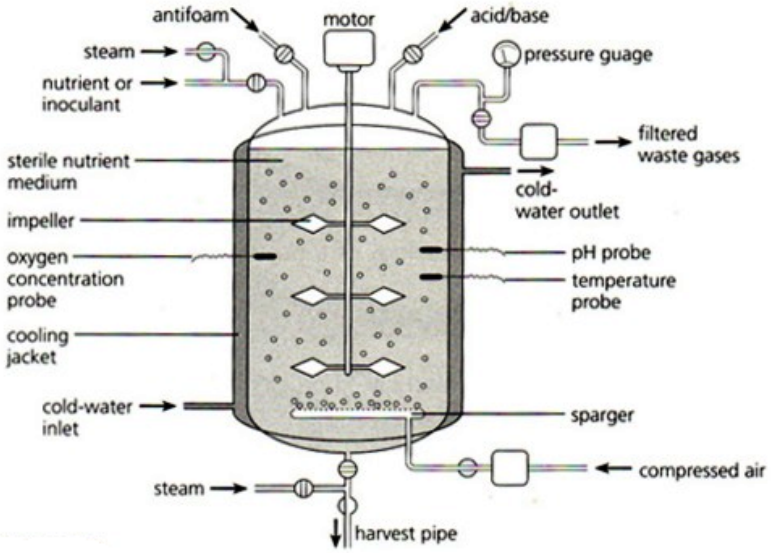
			
4d	**Propagation of yeast:** It is the process where a pure culture of brewer's yeast is propagated in sterile wort usually continuously under aseptic condition. **Process**: 1. Yeast culture is usually stored in a test tube or flask on a culture medium in a fridge .It is sometimes kept in a freezer or under liquid nitrogen. 2. The yeast cells are grown up in a series of laboratory steps ensuring purity at each step by aseptic transfer and selecting single colonies. They are aerated and shaken at around 20^{o}C to maximise yeast cell growth upto 5- 6 times. 3. Sterile wort is collected in a small yeast propagation vessel. The cool wort is pitched with the laboratory cultured yeast. Again the culture is maintained at around 20oC with oxygenation at high level to encourage cell mass growth. 4. The content of the smaller yeast propagation vessel is used to inoculate sterile wort in the next vessel. This is repeated until sufficient yeast has been produced to pitch a standard brew or fermentation vessel.	4	4
4 e	***Primary treatment*** involves separating a portion of the suspended solids from	4	4

	the wastewater. Screening and sedimentation usually accomplish this separation process. The effluent from primary treatment will ordinarily contain considerable organic material and will have a relatively high BOD. Primary treatment is required to recover chemicals from spent wash. It consists of neutralization, filtration, evaporation and incineration. Aim of primary treatment is to remove compounds present in the waste water by physical means. Chemical or biological methods are not used for this purpose. The objective of primary treatment is the removal of settleable organic and inorganic solids by sedimentation, and the removal of materials that will float (scum) by skimming. Approximately 25 to 50% of the incoming biochemical oxygen demand (BOD_5), 50 to 70% of the total suspended solids (SS), and 65% of the oil and grease are removed during primary treatment. Some organic nitrogen, organic phosphorus, and heavy metals associated with solids are also removed during primary sedimentation but colloidal and dissolved constituents are not affected. The effluent from primary sedimentation units is referred to as primary effluent. Primary sedimentation tanks or clarifiers may be round or rectangular basins, typically 3 to 5 m deep, with hydraulic retention time between 2 and 3 hours. Settled solids (primary sludge) are normally removed from the bottom of tanks by sludge rakes that scrape the sludge to a central well from which it is pumped to sludge processing units. Scum is swept across the tank surface by water jets or mechanical means from which it is also pumped to sludge processing units. Primary sludge is most commonly processed biologically by anaerobic digestion.		
4 f	**Industrial spirit** is distilled ethyl alcohol (C_2H_5OH), normally of high proof, produced and sold for other than beverage purposes. It is usually distributed in the form of pure ethyl alcohol, completely denatured alcohol, specially	2	4

	denatured alcohol and solvent blends. **Uses:** 1. Pure ethyl alcohol is used in laboratories and in industry for its sanitizing, cleaning and solvent properties. 2. Many medicines, food products, flavorings and cosmetics are made with ethyl alcohol. 3. It is also used to process vaccines, syrups, tinctures, liniments and antiseptics and in the manufacture of pharmaceuticals such as chloroform and barbiturates. 4. It may be used in the production of adhesives, cosmetics, detergents, explosives, inks, hand cream, plastics and textiles.	1 mark each for any 2	
5	Attempt any 4		16
5 a	**Byproducts of fermentation process in alcohol industry** 1. Carbon dioxide : Can be used as dry ice, in beverages 2. Fuse oil : Recovery of various chemicals 3. Effluent as feed stock for cattle 4. Effluent as fertilizer	1 mark each	4
5 b	**i) Bacteria:** They are microscopic organisms whose single cell has neither a membrane enclosed nucleus nor other membrane enclosed organelles like mitochondria and chloroplast. Eg: cocci, bacilli, spirilla **ii) Enzyme :** Enzymes are biological molecules (proteins) that act as catalysts and help complex reactions occur everywhere in life. **iii)Yeast:** It is a one celled fungus that converts sugar and starch into carbon dioxide and alcohol Eg: beer yeast, dry yeast, wine yeast **iv) Microorganism:** A microorganism or microbe is an organism which is too	1 mark each	4

	small to be seen by the unaided human eye. It is a microscopic living organism, which may be single celled or multicellular.		
5 c	**Flow diagram for manufacture of vodka**  	4	4
5.d	**Pollutants present in distillery waste water** 1. Alcohol 2. Colour 3. Total solids 4. Chlorides 5. Sulphates 6. Potassium 7. Heavy metals	4	4
5.e	**Morphology of yeast:** It is the description of – 1. the shape, size and internal structure of the yeast cells 2. changes during the reproduction of vegetative cells and the position of the newly formed cells to their parent 3. the changes the cells undergo when forming resting cells, ballistospores or	2	4

	asco spores 4. the size, shape, surface of spores, their number per ascus and mode of germination  	2	
5.f	**Stimulation of yeast** Stimulation is the factor that increases the rate of growth of yeast. The amount of stimulation depends on the strain of yeast used. Pantothenic acid has been shown to stimulate the growth of a number of strains of yeast. Pantothenic acid, also called pantothenate or vitamin B_5 (a B vitamin), is a water-soluble vitamin. Pantothenic acid is an essential nutrient. **Acclimatisation of yeast** When yeast is added to wort or media it goes through 5 basic stages of growth. Initially there is lag phase. This occurs during the first few hours after addition of yeast. During this time there is no sign of fermentation or growth. The yeast are becoming acclimated to their new environment. Major changes occurs within the yeast at this step, they are absorbing all the oxygen in the wort , using it to synthesize all the enzymes and other metabolic machinery necessary for growth and fermentations.	2 2	4

6	Attempt any 2		16
6.a	**Batch fermentation:** The reactor is filled with sterile nutrient substrate and inoculated with the microorganism. In the course of the entire fermentation, nothing is added except oxygen, an antifoam agent, and acid or base to control the pH. The fermentation process begins and continue until the number of cells in the fermenter is such that some of the contents of the fermenter can be removed without altering the number of cells in the fermenter. The culture is removed to grow until no more of the product is being made at which point the reactor is harvested and cleaned out for another run e.g. For the production of ethanol form molasses  	5 3	8
6.b	**Manufacture of whisky** Three basic ingredients are needed - water, barley and yeast. There are five stages to the process - malting, mashing, fermentation, distillation and maturation.	5	8

Step 1 – Malting

Barley contains starch and it is this starch which needs to be converted into soluble sugars to make alcohol. For this to occur, the barley must undergo germination and this first part of the prodess is called 'malting'. The barley is soaked for 2-3 days in warm water and then traditionally spread on the floor of a building called a malting house. It is turned regularly to maintain a constant temperature. This is also carried out on a commercial scale in large drums which rotate. When the barley has started to shoot, the germination has to be stopped by drying it in a kiln. Traditionally peat is used to power the kiln and it is at this point where the type of peat used and length of drying in the peat smoke can influence the flavour of the final spirit. The barley is now called 'malt' and this is ground down in a mill, with any husks and other debris being removed.

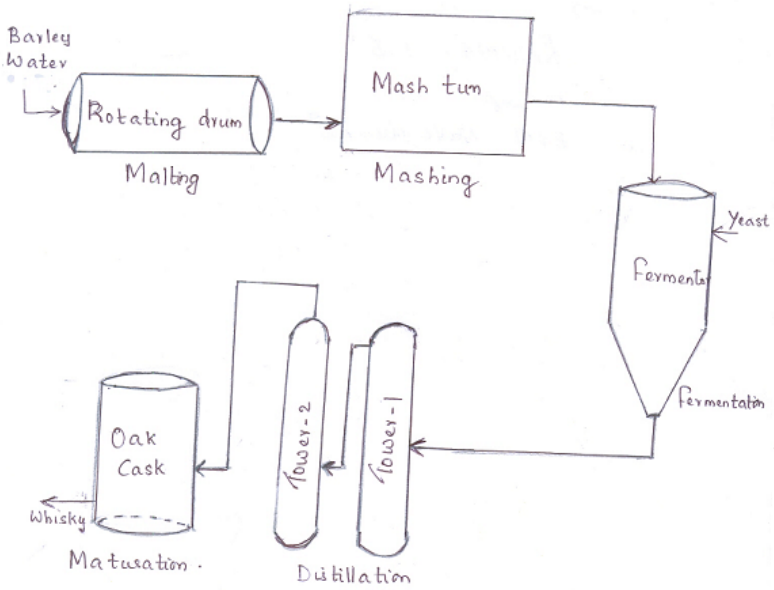
Step 2 – Mashing

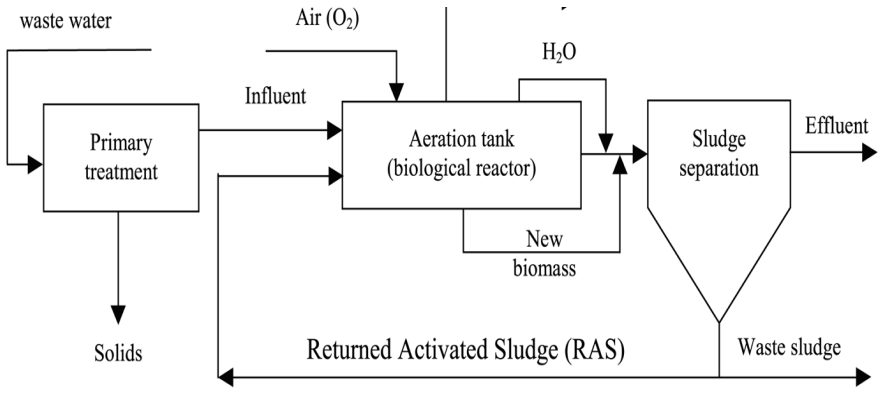
The ground down malt, which is called 'grist', is now added to warm water to begin the extraction of the soluble sugars. The liquid combination of malt and water is called the 'mash'. It is put into a large vessel called a mash tun and stirred for several hours. During this process, the sugars in the malt dissolve and these are drawn off through the bottom of the mash tun. The resulting liquid is called 'wort'. This process is normally carried out three times with the water temperature being increased each time to extract the maximum amount of sugar. Only wort from the first two times is used. The third lot is put back into the next batch of new grist. Any residue, such as husks, is called 'draff'. This is collected and used in the production of farm feed.

Step 3 – Fermentation

The wort is cooled and passed into large tanks called washbacks. These are

	traditionally made of wood, but now a number of distilleries use stainless steel. Here the yeast is added and the fermentation begins. The yeast turns the sugars that are present into alcohol. The fermentation normally takes around 48 hours. The liquid at this stage is called 'wash' and is low in alcohol strength (between 5-10% ABV), like beer or ale **Step 4 – Distillation** The wash is distilled twice. The stills are made from copper, which has been found to be the best material for extracting impurities from the spirit as it is being distilled, and consist of a bowl shape at the bottom that rises up to the neck at the top. All are the same in principal, but a different shape will give a different flavour and character to the final spirit. Taller stills with longer necks will give finer, lighter spirits while shorter, fatter stills will produce a fuller, richer spirit. **Step 5 – Maturation** The spirit is put into oak casks and stored. During maturation, the flavors of the spirit combine with natural compounds in the wood cask and this gives the whisky its own characteristic flavor and aroma. Wood is porous, so over time it will breathe in air from the surrounding environment in which it is stored. This will also give the whisky some unique characteristics.		

		3	
6.c	**Activated sludge treatment** Activated sludge plant involves: 1. Wastewater aeration in the presence of a microbial suspension, 2. Solid-liquid separation following aeration, 3. Discharge of clarified effluent, 4. Wasting of excess biomass, and 5. Return of remaining biomass to the aeration tank. In activated sludge process wastewater containing organic matter is aerated in an aeration basin in which micro-organisms metabolize the suspended and soluble organic matter. Part of organic matter is synthesized into new cells and part is oxidized to CO_2 and water to derive energy. In activated sludge systems the new cells formed in the reaction are removed from the liquid stream in the form of a flocculent sludge in settling tanks. A part of this settled biomass, described as activated sludge is returned to the aeration tank and the remaining	5	8

	forms waste or excess sludge.  	3	