***Answer All Questions.** ***Using neat Sketches for Aid Your Answers.**

Question (1): [30 Marks]

1. What a concept of the geothermal energy? **(1 Mark)**, List some practical applications of the geothermal energy. **(1 Mark)**, draw the cycle power plant. **(1 Mark)**, and Explain the biomass energy principles? **(2 Marks)**
2. Discuss one practical application of plants as renewable energy source. **(5 Marks)**
3. List the types of Hydrogen cells? **(3 Marks)**, and what is the operating principles? **(2 Marks)**
4. Show types of ocean energy? **(3 Marks)**, and what is the tidal energy? **(2 Marks)**
5. What is the working principle of hydroelectric energy? **(1 Mark)**, Draw the cross-section of typical power plant. **(2 Marks)**, and List the main components of this plant. **(2 Marks)**
6. Define the nuclear power. **(2 Marks)**, discuss the main components of plant? **(3 Marks)**

Question (2): [30 Marks]

1. Explain the main factors governing the selection of site for a proposed wind turbine generator. **(2 Marks)** Discuss the economic and environmental effects of producing and using wind energy. **(2 Marks)**, what is the effect of deregulation on the future of the wind industry? **(1 Mark)**
2. Show types of wind turbines. **(3 Marks)**, what are the types of electric generators used in wind energy? **(2 Marks)**
3. Explain a wind energy generating system and mention the function of each part. **(5 Marks)**
4. Deduce an expression for the wind generator output power in terms of different wind energy coefficients. **(5 Marks)**
5. Show, in detail, one project that is based on wind energy resources in Egypt. **(5 Marks)**
6. Calculate the maximum power extracted in a wind moving with speed 5 $m.s^{-1}$ incidents on a wind turbine with blades of 100 m diameter (Assume the density of air is 1.2 $Kg.m^{-3}$). **(5 Marks)**

Look at the back of the paper

Question (3): [30 Marks]

1. How solar energy is used? **(2 Marks)**, List some application for it. **(3 Marks)**
2. What are the types of solar thermal systems? **(2 Marks)**, List the types of solar thermal power plants. **(3 Marks)**
3. What is photovoltaic? **(2 Marks)**, what is the mechanism of generating power for it? **(1 Marks)**, and List the various types of PV cell. **(2 Marks)**
4. What are the components of solar photovoltaic systems? **(5 Marks)**
5. What are the solar ponds? **(2 Marks)**, what is working principle? **(2 Marks)**, and what are the types of it? **(1 Mark)**
6. A station to reinforce TV antenna uses photovoltaic panels of 2.8A and 12V the station works 16 hours during it needs 4A and 48 DC volts. At off-time, the station need 1A and 48V cover essential loads. The minimum sun site is 9 hours during the day. Consider 1.2 safety factor. Find:
   a. The average current required to cover this load. **(1 Mark)**,
   b. The total number of panels used. **(2 Marks)**,
   c. Draw a complete proposed project circuit. **(1 Mark)**,
   d. Discuss the main reasons for using the bypass diodes in this system. **(1 Mark)**

***Questions are ended.**

Best Wishes for All,

On the Committee of Examiners,

Dr. Mohamed H. Shaalan

Model Answer of Final Written Exam

E1534 - New and Renewable energy

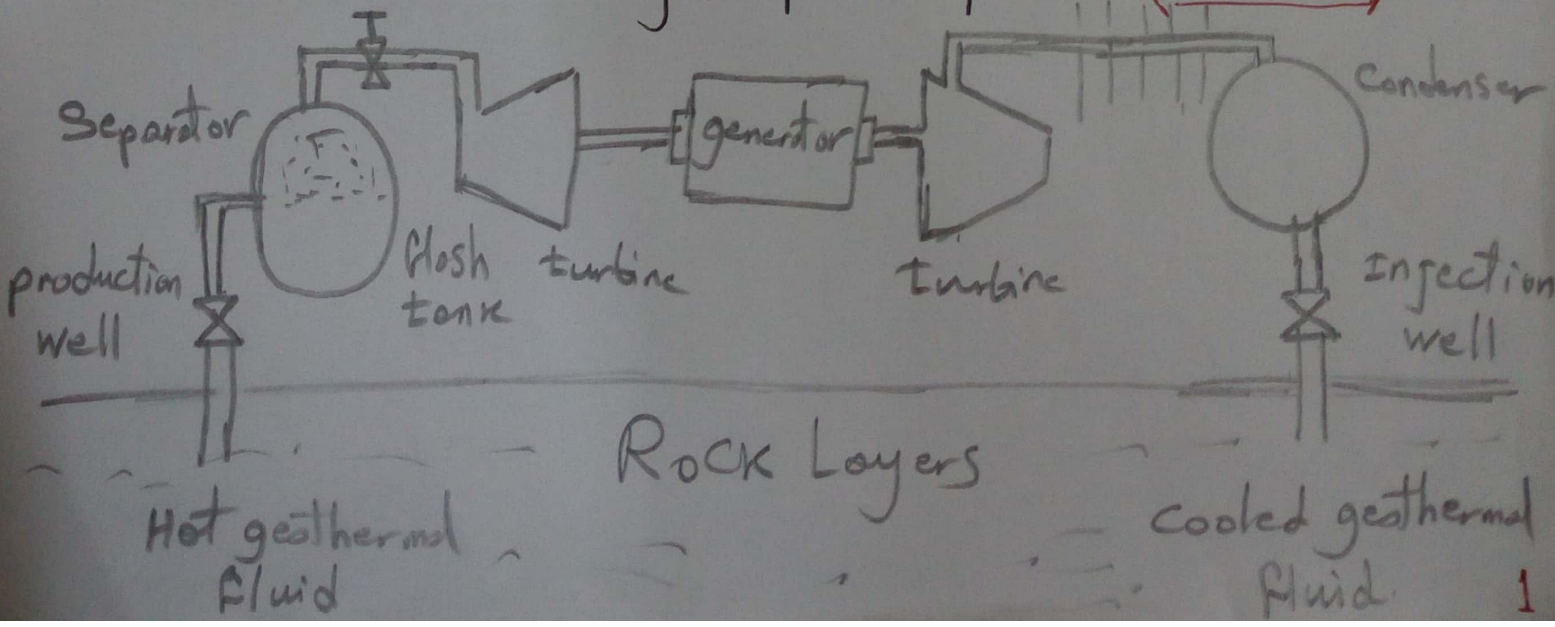
4th Year - 2nd term - 2018-2019 - Total mark [90 Marks]

Question (1): [30 Marks]

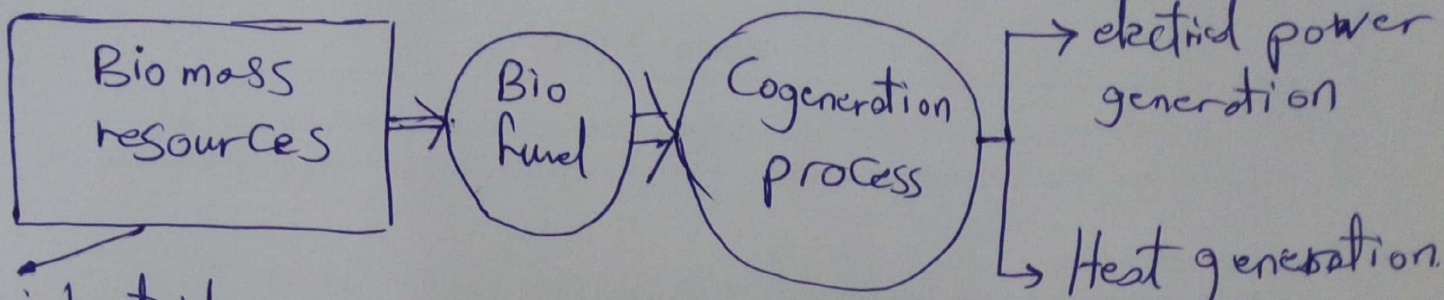
1 *A concept of the geothermal energy (1 Mark)
is heat drived with in the sub-surface of the earth. water and/or steam Carry the geothermal energy to the earth's surface. we can used for heating and cooling purposes or be harnessed to generate clean electricity, and generation high or medium temperature resources are needed.

* List of some practical applications of the geothermal energy (1 Mark)
- Some application use the earth's temperature near the surface, while others requiredrilling miles into the earth,
- 3 main types of geothermal energy systems:
① Direct use and district heating systems.
② Electricity generation power plants.
③ geothermal heat pumps.

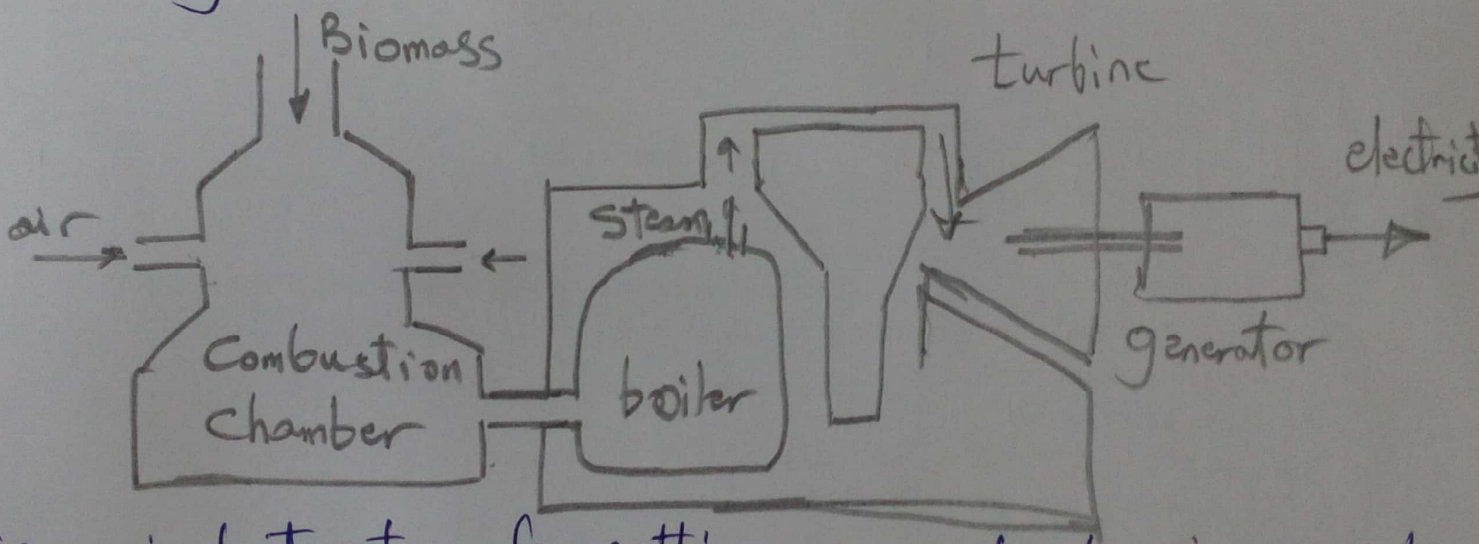
* The geothermal cycle power plant: (1 Mark)



* The Biomass energy principles : (2 Marks)

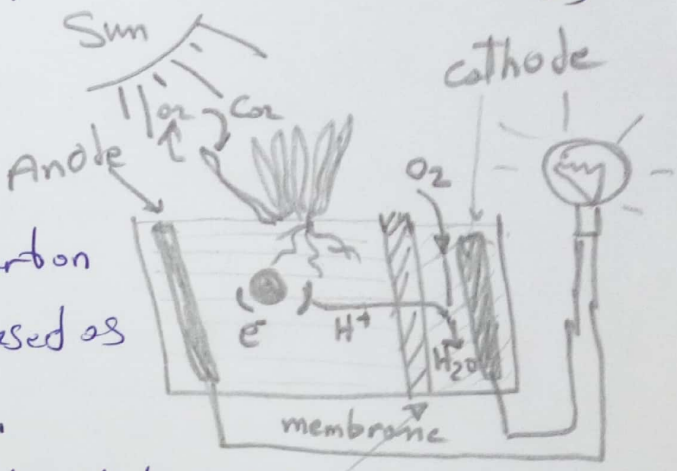


① industrid resources
② Animal and plant resources
③ Municipal solid waste.
④ Sewage.
⑤ Agricultural crops & residues.
⑥ Foresty crops & residues.



- is an industry term for getting energy by burning wood and other organic matter.
- Can used directly via Combustion to produce heat.
- " " indirectly after Converting it to various forms of biofuel by different methods which are classified into : ① Thermal, ② chemical.

[2] one pretical application of plants as renewable energy Source: (5 Marks)

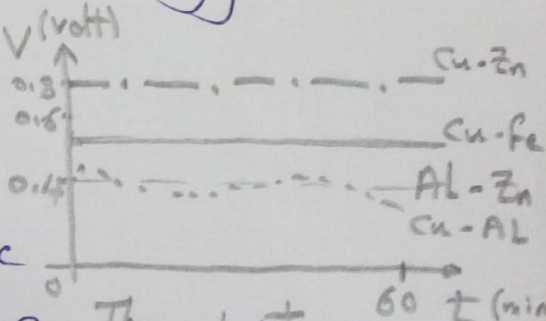


* plant power principle :

- Co_2 is fixed by plant leaves using Solar energy - part of the fixed carbon is transported to the roots and released as Small molecular weight components.
- These so-called exudates are partly utilized by electrochemically active micro-organisms yielding Co_2, protons and electrons.
- Co_2 is returned to the atmosphere. Electrons are transferred by elechrochemically active micro-organisms to the anode for gaining metabolic energy.
- The anode is coupled to a cathode, and produce a potential difference between them, the electrons flow from the anode through an electrical circuit with a load to cathode.
- To retain electro-neutrality a proton is transpoted through the membrane from the anode to the cathode.

* Investigation of type of electrodes and energy Sources:

- The current work selects 3 different kinds of plants which were pulai tree, banana tree, and also aloe vera.
- 4 different materiol of electrodes have been selected are Copper, ferum, Zinc and aluminum
- 4 distinct pairs of electrodes (Cu-fe, Cu-Zn, AL-Zn, Cu-AL) were used.



The pulai trees.

3 * The list of types of Hydrogen Cells: (3 Mark)

- 3 general categories to produce H_2
  ① Thermal process ② electrolytic process
  ③ photolytic process.

* The operating principles: (2 Marks)

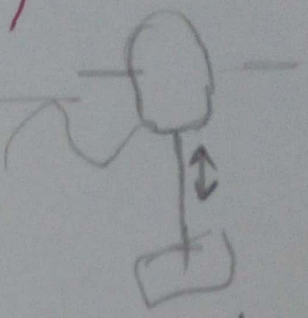
①- Thermal process: use the energy in resources including natural gas, coal, or biomass to produce H_2,
- Thermal process include: ⓐ Natural gas reforming
ⓑ gasification ⓒ Renewable liquid fuel reforming
ⓓ High temperature water splitting.

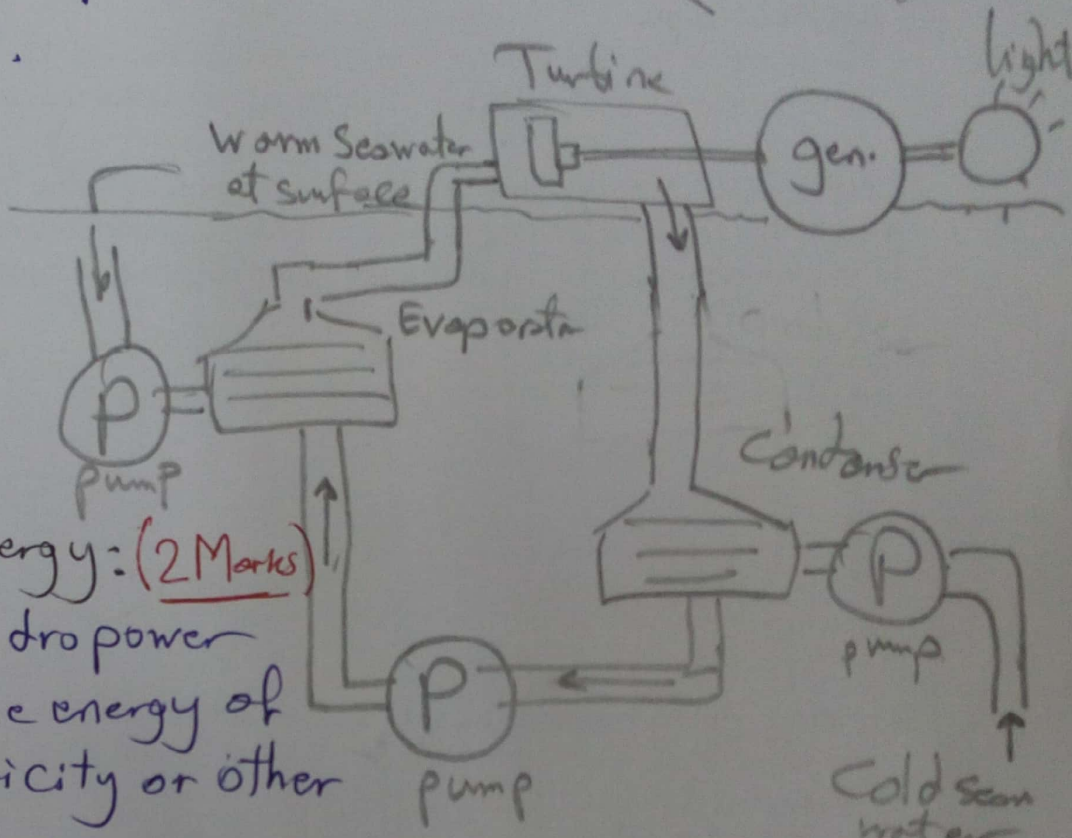
②- Electrolytic process: use electricity to split water into hydrogen and oxgyen in a unit called an electrolyzer.
- electrolyzer consist of an anode and cathode separated by an electrolyte that determines the type of electrolyzer and its operating conditions.

③ photolytic processes: use light energy to split water into hydrogen and oxygen.
- photolytic processes include:
ⓐ photobiological water splitting.
ⓑ photoelectrochemical water splitting.

4 * Types of ocean energy: (3 Marks)

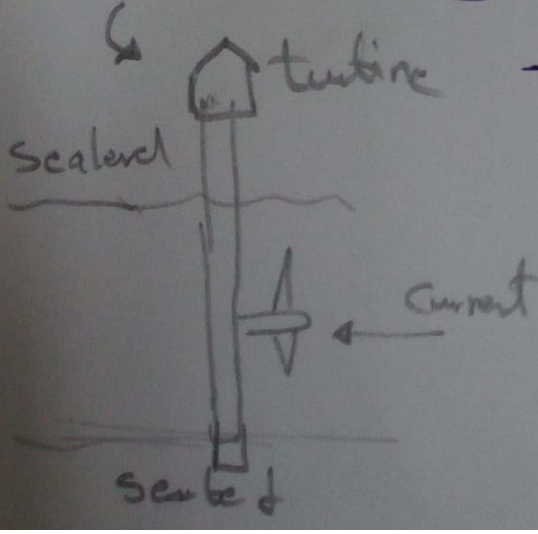
1. Ocean waves.
2. Salinity
3. Ocean temperature differences.
4. Tides.





* The tidal energy: (2 Marks)

- is a form of hydropower that converts the energy of tides into electricity or other useful forms of power.
- Tidal forces produced by the Moon and Sun, in combination with Earth's rotation, are responsible for the generation of the tides
- Tidal power plants: ① Tidal barrages (similar to dam) ② Tidal turbines ③ Tidal fences

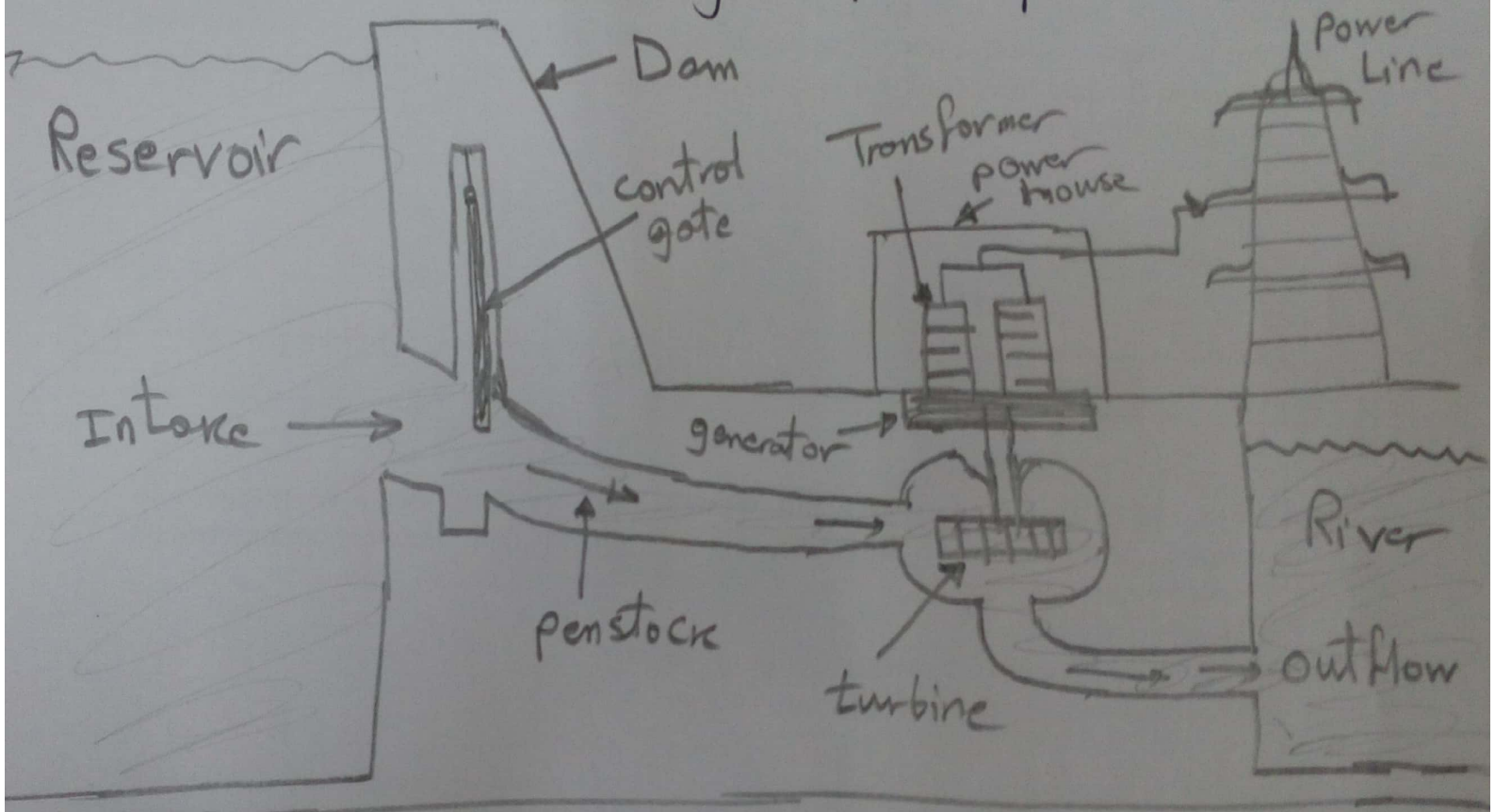


- Technology case study
  Sihwa Lake tidal power station

5 * The working principle of hydroelectric energy: (1Mark)

- Hydro electric energy is operated by requiring a large artificial reservoir of water called the dam. The dam is built with tunnels where water can pass through. The flowing of the water creates the energy to turn the turbines which turn the generators, converting energy into electrical energy.

* The Cross-section of typical power plant: (2Mark)



* The list of the main components of this plant: (2Marks)

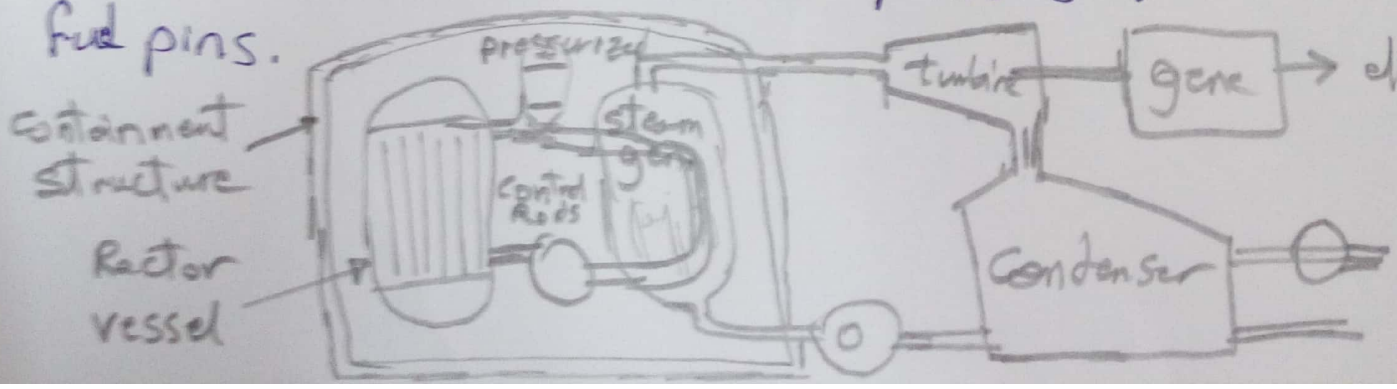
① Dam and Reservoir.
② control gate.
③ penstock
④ water turbine
⑤ generator.
⑥ Surge tank.

6 * The nuclear power : (2 Marks)
is the use of nuclar reactions that release nuclear energy to generate heat, which most frequantly is then used in steam turbines to produce electricity.

- 2 ways to obtain Nuclear energy :
① Nuclear fission (انشطار نووي)
② Nuclear fusion (اندماج نووي)

- Types of Nuclear Reactors :
① pressurized water Reactor (PWR)
② Boiling water Reactor (BWR)
③ pressurized Heavy water Reactor (PHWR)
④ Gas cooled Reactor (GCR)
⑤ Liquid Metal Fast Breeder Reactor (LMFBR)
⑥ pebble Bed Reactor (PBR)
⑦ Molten Salt Reactor (MSR)
⑧ Aqueous Homogeneous Reactor (AHR)

* The main Components of plant : (3 Marks)
- That Nuclear Reactor
- The core of the reactor contains all of the nuclear fuel and generates all of the heat.
- it contains ① Low-enriched Uranium (<5% U-235), ② Control systems, ③ structural materials.
- The core can contain hundreds of thousands of individual fuel pins.



Question (2): [30 Marks]

1 * The main factors governing the selection of site for aproposed wind turbine generator : (2 Marks)

① Wind availability : wind speed ≥ 9 m/s /hr

② Land " : as installation requires Large wind farms 1MW requires about 25 acres. , 1 acres ≃ 4000 m^2

③ Access to Land : Land should be accessable for transportation of machinery & construction material.

* The economic and environmental effects of producing and using wind energy : (2 Marks)

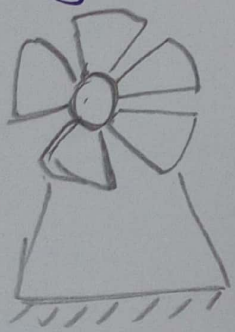
- wind energy is clean, wind mills produce no air or water pullution
- The blades of wind M/C's may affect bird populations (Migration) & can produce noise.
- wind farms can take up to hundreds of acres of Land which can be used for Crops & grazing after the wind mills are installed.
- one wind m/c can produce ≃ 275 Mwh - 500 Mwh of electricity (this is engugh to power ≃ 50 homes.

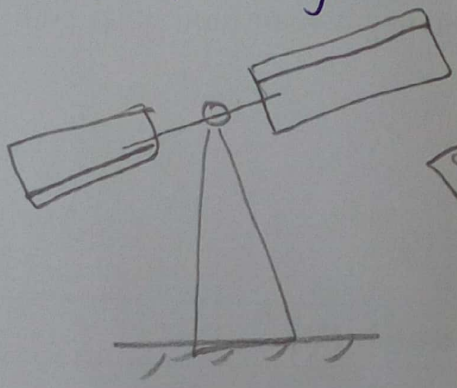
* The effect of deregulation on the future of the wind industry: (1 Mark)

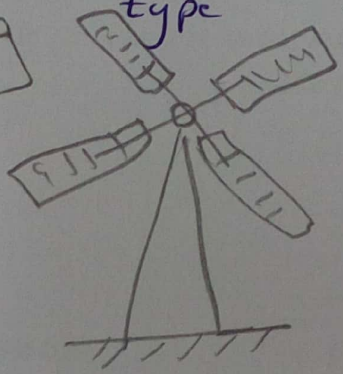
- De-regulation aims that each customer can take electricity from Several companies according to their offers & Services (تنافسي وتجاري) Competing to win more Customers.
- So as de-regulation increases, the wind energy industry increases as there are few places that have wind 9 m/s/hr.

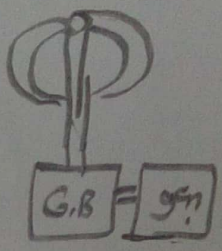
2 * Types of wind turbines: (3 Marks)

- According to axis
  - Horizontal axis wind turbine
    - Multi-blade type
    - propeller type (المروحي)
  - vertical axis wind turbine
    - 4 blade type
    - Savonius type
    - Darrieus type
- According to speed
  - Constant speed (Synch)
  - variable speed (DFIG)





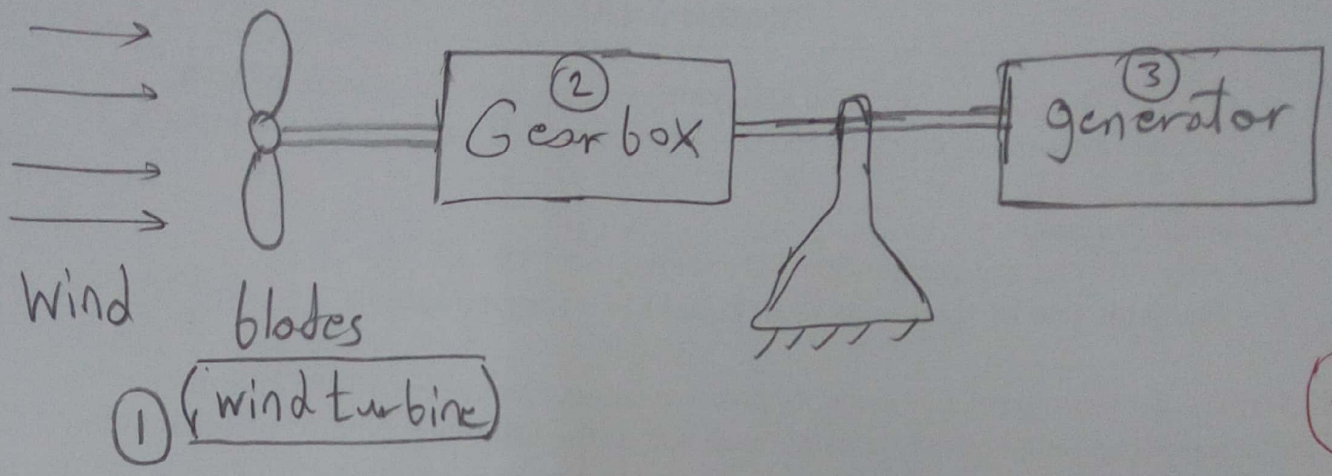




* The types of electric generators used in wind energy: (2 Marks)

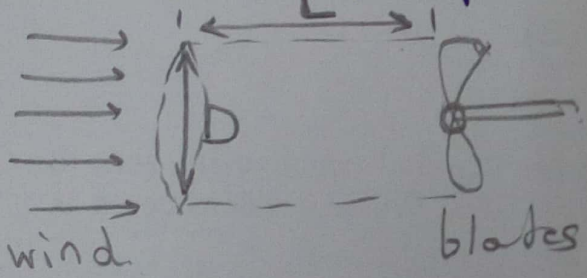
- DC machines: for Low generation (0 - 50 kw)
- medium generation (50 - 500 kw), we use induction generator.
- high generation (> 500 kw), we use Synchronous generator or induction generator. (DFIG)

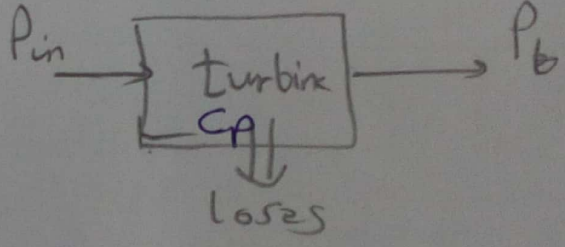
3 A wind energy generating system: (5 Marks)
with the function of each part:



4 An expression for the wind generator output power in terms of different wind energy coefficients: (5 Marks)

1* Input / output power of wind turbine:





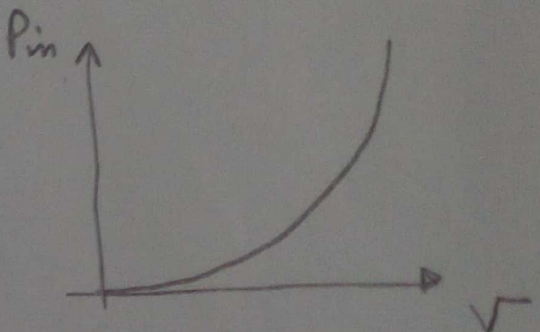
Kinetic energy of wind $K.E. = \frac{1}{2} m v^2$ where, $m = \rho * \text{volume}$

m = air mass, ρ = air density, v = wind speed.

$\text{Volume} = AL = \frac{\pi D^2 L}{4}$, A = Swept (air) area.

$\therefore K.E = \frac{1}{2} \rho A L v^2$ $\quad v = \frac{dL}{dt} = L / \text{time}$

$\therefore P_{in} = \frac{K.E.}{\text{time}} = \frac{1}{2} \rho A v^3$



C_p = coefficient of performance

$P_b = C_p * P_{in} = C_p * \frac{1}{2} \rho A v^3$

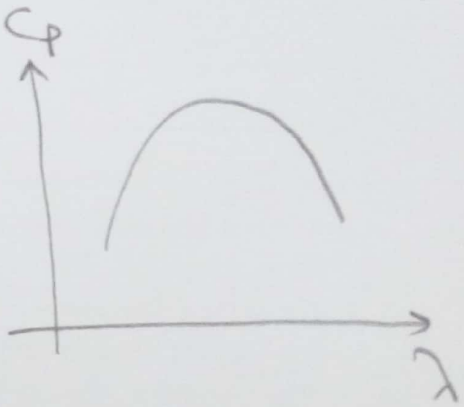
$0 < C_p < 1$ by Lanchester & Betz.

Found an expression for maximum C_p

$= \frac{16}{27} \simeq 60\% \cong 59\%$

C_p is dependent on tip-speed ratio (λ)

$$\lambda = \frac{\text{Speed at rotor tip}}{\text{wind speed}} = \frac{V_{tip}}{V = u_o}$$



ex: $u_o = 8$ m/sec

$V_{Tip} = 62$ m/sec $>> u_o$

$\therefore \lambda \geq 7$

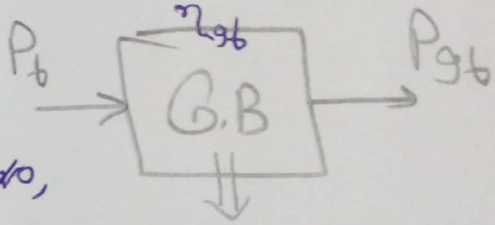
2 ⊛ Gear box: $F = \frac{pN}{60}$

where $2p$ = no of poles, N = rpm Speed, f = freq.

ex: for $f = 50$ Hz, If $p = 1 \Rightarrow N$ should $= 3000$ rpm

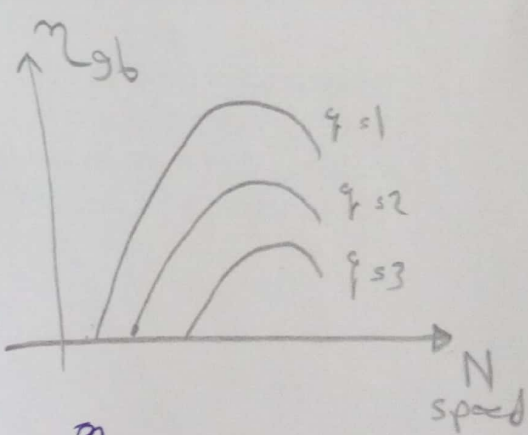
If $p = 2 \Rightarrow N$ " $= 1500$ rpm.

- gear box is to increase the speed to the required Level.
- gear box system, could be one, two, or three stages where each stage increases speed to nearly 6 times.



η_{gb} = gear box efficiency

η_{gb} -- depends on q = no. of stage used

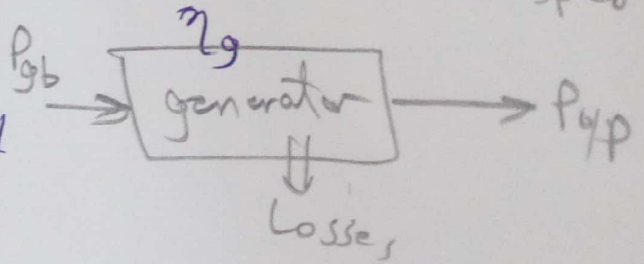


$$P_{gb} = \eta_{gb} * P_b$$

$$= \frac{1}{2} \rho A C_p \eta_{gb} V^3$$

3 * Generator:

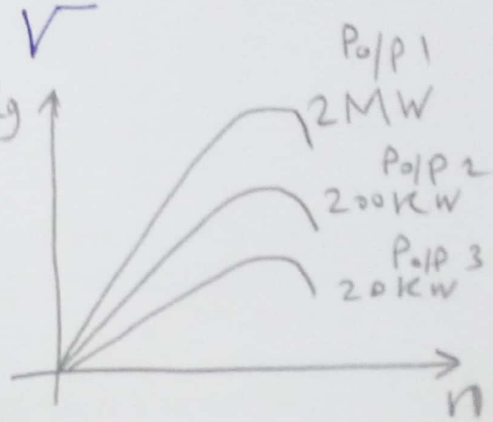
η_g = generator efficiency depend on o/p power required & its speed.



$$P_{o/p} = \eta_g \; P_{gb}$$

$$\therefore P_{o/p} = \underbrace{(\eta_g \eta_{gb} C_p)}_{\text{called overall efficiency}} \frac{1}{2} \rho A V^3$$

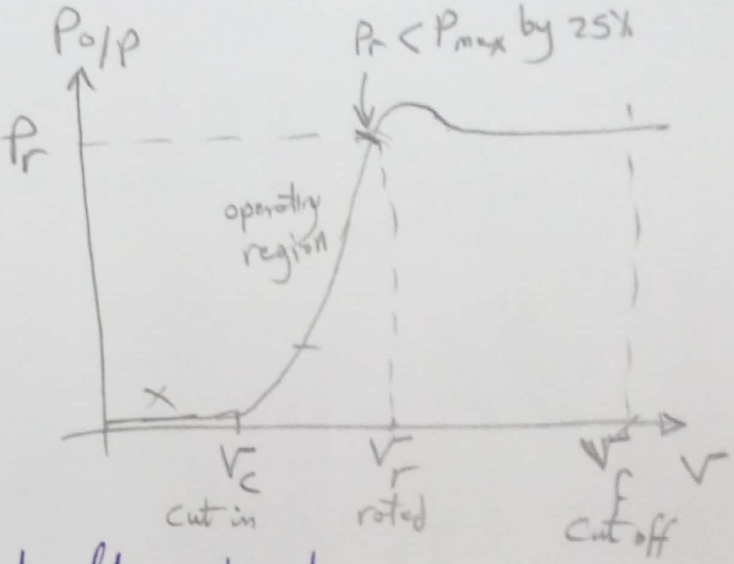
$$= \frac{P_{o/p}}{P_{I/p \text{ from wind}}} = \frac{P_{o/p}}{\frac{1}{2}\rho A V^3}$$



$\rho_{air} = 1.25 \text{ kg/m}^3$

V_c = Cut in wind speed

= minimum wind speed to give output power



if $V < V_c \therefore P_{o/p} = 0$

V_f = cut off (cut-out) speed

= maximum wind speed just after which mechanical damage could occure to the system.

V_r = rated wind speed (designed to give rated power)

---

5 In detail, one project that is based on wind energy resources in Egypt. (5 Marks)

Zaffrana

6 (5 Marks)

$V = 5\ m/s$ $\qquad \rho = 1.2\ kg/m^3$

$D = 100\ m$, $\Rightarrow A = \pi\left(\frac{D}{2}\right)^2 = \pi \times (50)^2$

$P_{max} = 59\%\ of\ \left(\frac{1}{2}\rho A V^3\right)$

$= 0.59 \times \frac{1}{2} \times 1.2 \times \pi \times (50)^2 \times (5)^3$

$= 0.59 \times 0.59 \times 10^6\ W$

$\therefore = 0.35\ MW$ ✻

Question (3): [30 Marks]

1 * Solar energy is used : (2 Marks)

Via ① thermal panels.

Via ② photovoltaic. (solar panels).

* Some application for it : (3 Marks)

① solar water heater
② Solar thermal power
③ Solar Cooking. & crop drying
④ Solar thermal ventilation.
⑤ Solar cell to converting the Solar energy to electrical energy
// The light energy to electrical energy

PV ←

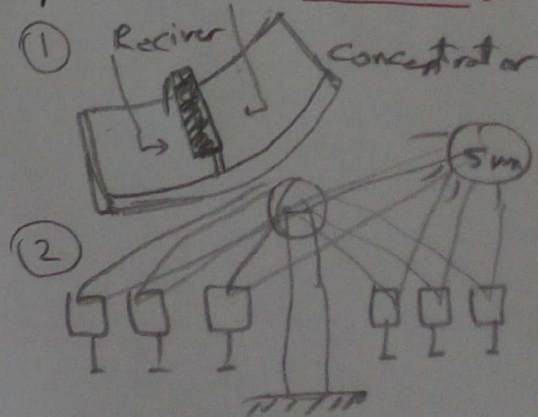
2 * The types of Solar thermal systems : (2 Marks)

There are 2 types

① passive system
② Active system.

* The types of solar thermal power plants : (3 Marks)

① parabolic through system.
② Solar power tower systems.
③ Solar dish/engine System.
④ compact linear frensel reflector



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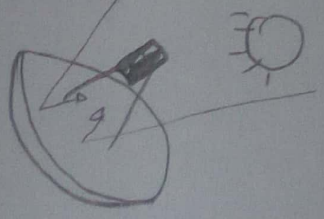

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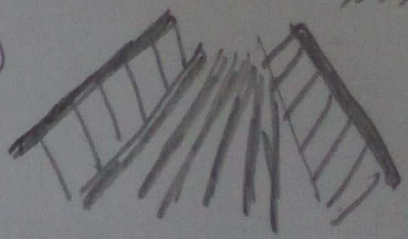


3 * photo voltaic : (2 Marks)

A method of generating electrical power by converting Solar radiation into direct current electricity through Some materials (such as Semiconductors).

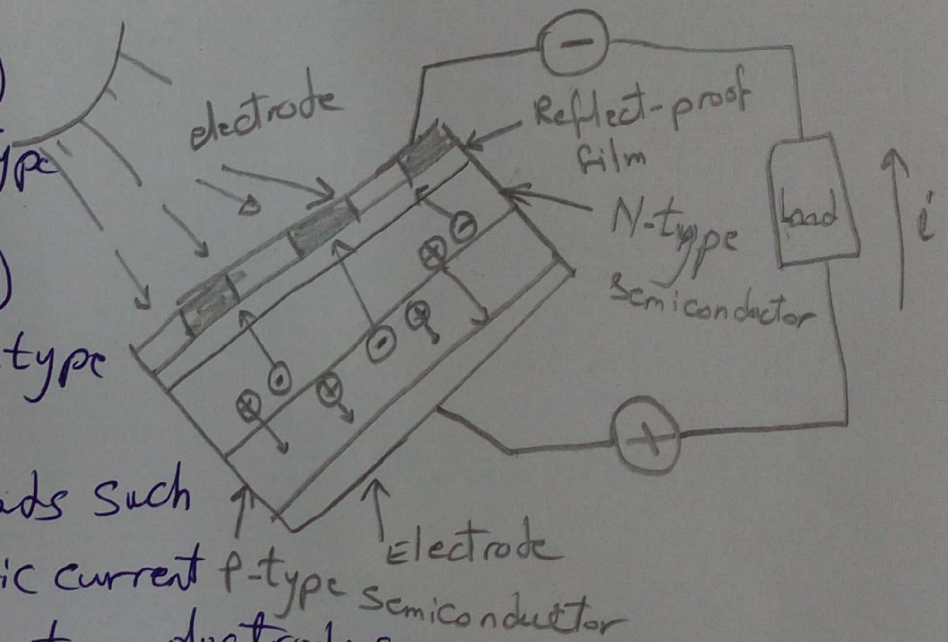
* The mechanism of generating power for PV : (1 Mark)

the Solar cell is composed of a p-type Semiconductor and an N-type Semiconductor, Solar light hitting the cell produces two types of electrons, negative and positively charged electrons in the Semiconductors.

→ (-ve charged electrons) gather around th N-type Semiconductor

→ (+ve charged electrons) gather around the p-type Semiconductor.

→ When you connect Loads such as a light bulb, electric current flows between the two electrodes.



* The various types of PV Cell : (2 Marks)

① Mono-Crystalline Solar panels (Single Crystalline)

② poly Crystalline Solor panels.

③ Amorphous Silicon also called "Thin Film".

4 The components of solar photovoltaic systems: (5 Marks)

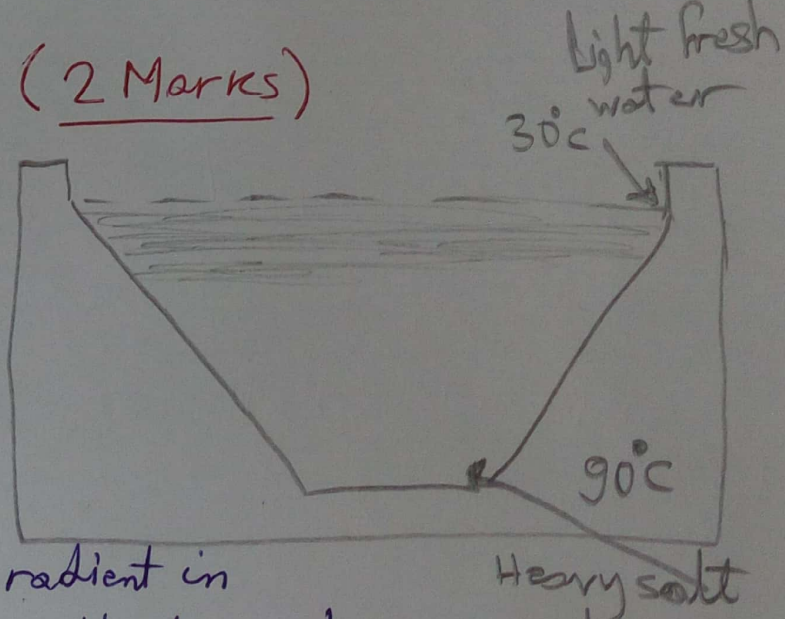
1. Solar array
2. Battery
3. Charge controller.
4. inverter
5. Loads (DC, AC)

5 * The Solar ponds: (2 Marks)

- is a pool of salt water which acts as a large-scale solar thermal energy collector with integral heat storage for supplying thermal energy.
- Uses radiation from Sun to heat water.

* The working principle: (2 Marks)

- Solar pond contains layers of salt solutions with increasing concentration to a certain depth.
- when solar radiation is absorbed → the density gradient in solar pond prevents heat in the lower layers from moving upwards by convection and leaving the pond.



* Types of solar ponds: (1 Mark)

1. Convecting Solar pond. (shallow & saltless)
2. Non Convecting Solar pond. (membrane & salt gradient)

6

Unit (PV)	Load
$V_u = 12\ V$	$V_L = 48\ V$
$I_u = 2.8\ A$	$I_{L_{on}} = 4\ A$ $\quad t_{on} = 16\ hr$
$t_u = 9$ hours	$I_{L_{off}} = 1\ A$ $\quad t_{off} = 24-16 = 8\ hr$
	Safety factor $= 1.2$

(a) The average current required to cover this Load: (1 Mark)

$$I_{av_L} = \frac{I_{L_{on}} \times t_{on} + I_{L_{off}} \times t_{off}}{24}$$

$$= \frac{4 \times 16 + 1 \times 8}{24} = 3\ A\ *$$

(b) The total * of panels used: (2 Mark)

** Series unit $= \frac{V_L}{V_u} = \frac{48}{12} = 4$ units

** parallel unit $= \frac{\text{Ampere hours of load}}{\text{Ampere hours of unit}} =$

$$= \frac{(I_{L_{on}} \times t_{on} + I_{L_{off}} \times t_{off}) * \text{Safety factor}}{I_u\ t_u}$$

$$= \frac{(4 \times 16 + 1 \times 8) * 1.2}{2.8 \times 9} = \frac{86.4}{25.2} = 3.4 \cong 4\ \text{unit}$$

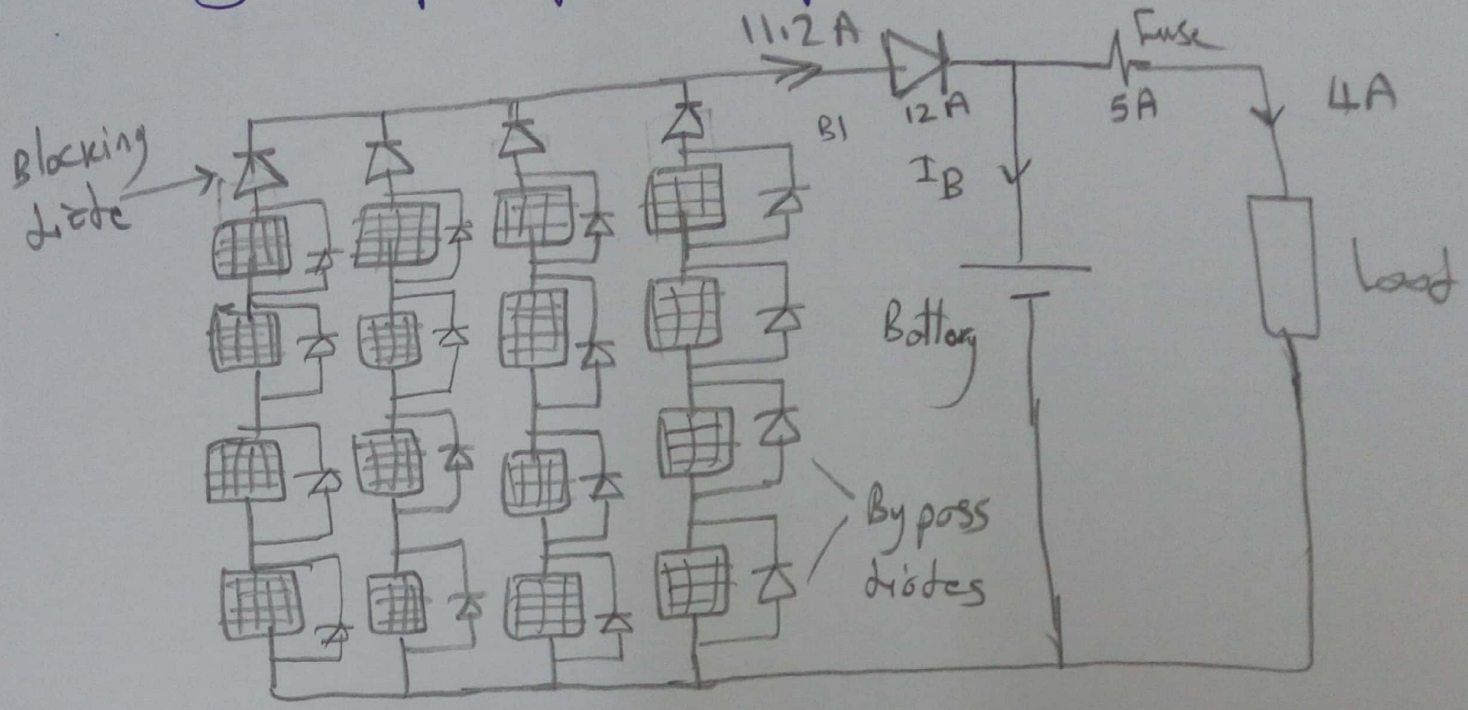
The total * of units = * of Series unit x * of parallel unit

$= 4 \times 4 = 16$ unit. *

* Total current = * of parallel unit x I_u

$= 4 \times 2.8 = 11.2\ A$ *

© Complete proposed project c.t. (1 Mark)



(d) The main reasons for using the bypass diodes in this System (1 Mark)

- Bypass diodes (called a string)
- one in parallel with each solar panel to provide a low resistance path, safely carry this short circuit current.
- protect the cells that can be exposed to partly shaded as they turn into a load and pull the current, and works the rest of the cells without problems.
- protect the cells that are exposed to dirt or bird droppings from the phenomenon of hot spots where they also turn out as a loads.