WATER RESOURCE ENGINEERING FINAL EXAMINATION

INSTRUCTIONS: ATTEMPT ALL THE QUESTIONS IN SECTION A AND ANY TWO FROM SECTION B AND ANY ONE FROM SECTION C

SECTION A – ATTEMPT ALL THE QUESTIONS – 70 Marks

1. In water resources engineering, the hydrological cycle consists of FOUR key components. Discuss them briefly. **(20 Marks)**
   i. Precipitation – This occurs when atmospheric moisture becomes too great to remain suspended in the clouds. It denotes all forms of water that reach the earth from the atmosphere, the usual forms being rainfall, snowfall, hial, frost and dew. Once it reaches the earth's surface, precipitation can become surface water runoff, surface water storage, glacial ice, water for plants, ground water or may evaporate and return immediately to the atmosphere. Ocean evaporation is the greatest source of precipitation with about 90%.
   ii. Runoff – This is the water that flows across the land surface after a storm event. As rain falls over land, part of that gets infiltrated by the surface as overland flow. As the flow bears down, it notches out rills and gullies which combine to form channels. These combine to the flow of a river and is called a river basically or a watershed.
   iii. Storage – A portion of the precipitation that fall on land surface doesn't necessarily flow out as runoff but gets stored as either surface water bodies such as lakes, reservoirs and wetlands or sub-surface water body, usually called ground water.
   iv. Evapotranspiration – This is actually the combination of two terms; Evaporation and Transpiration. Evaporation is the process of liquid converting into vapour through wind action and solar radiation and returning to the atmosphere. Evaporation is the cause of loss of water from open bodies of water such as lakes, rivers oceans and the land surface. Evaporation provides upto 90 percent of the earth's precipitation. Transpiration is the process by which water molecules leaves the body of a living plant and escapes to the atmosphere. The water is drawn up by the plant

root system and part of that is lost through the tissues of plant leaf (through stomata).

2. State FIVE uses of water **(10 Marks)**
   - Domestic use such as cooking etc
   - Agricultural use such as farming and animal rearing
   - Health and hygene such as drinking and washing
   - Ecological needs such as rivers re filling and environmental restoration
   - Navigation such as with boats and ships
   - Cultural and traditional uses
   - Energy uses such as hydropower
   - Entertainment uses such as scenic natural views

3. State and explain the three MAIN supply of water. **(10 Marks)**
   i. Rainfall – this is water drawn before it reaches the ground for example from the rooftop etc.
   ii. Surface water bodies – This are static water bodies such as lakes and ponds and flowing water bodies such as sterams and rivers which can be sources of supply of water. Water bodies such as these would be even more utilized further by constructing dams across for example rivers, to satisfy ever growing needs of a particular area.
   iii. Ground water reservoirs – This is water stored in the soil and pores of fractured bed rocks and may be extracted to meet the demand of water. This includes wells or tube wells.

4. What do you understand by the following terms **(10 Marks)**
   i. Hydology – This is a science which deals with the occurrence, distribution and disposal of water on the earth.

ii. Hydrological cycle – This is the water transfer cycle which occurs continuously in nature.
iii. Condensation – this is the process in which water vapor in the air is changed into liquid water. Condensation is crucial to the water cycle because it is responsible for the formation of clouds. These clouds may produce precipitation which is the primary route for water to return to the earth's surface within the water cycle. Condensation is the opposite of evaporation
iv. Evaporation – This is the process by which water changes from liquid to a gas or vapor. Evaporation is the primary pathway that water moves from the liquid state back into the water cycle as atmospheric water vapor.
v. Flood – this may be defined as a great flow of water more than is usual.floods cause much loss of life and property, disruption of communication, damage to crops, famine, epidemic disease and other indirect losses.

5. State FIVE factors affecting infiltration rate of water into the soil **(5 Marks)**
   i. Initial moisture content
   ii. Condition of the soil surface
   iii. Hydraulic conductivity of the soil profile
   iv. Texture
   v. Porosity
   vi. Degree of swelling of soil colloids
   vii. Organic matter
   viii. Vegetative cover
   ix. Duration of irrigation or rainfull
   x. Viscosity of water

6. State FIVE factors affecting runoff **(5 Marks)**
   i. Precipitation characteristics
   ii. Shape and size of catchment

iii. Topography
iv. Geological characteristics
v. Meterological characteristics
vi. Storage characteristics of a catchment

7. State FIVE causes of water shed deterioration. **(5 Marks)**
   i. Uncontrolled, unplanned, unscientific land use and intervention
   ii. Cultivation on slopping land with adequate precautions
   iii. Cultivation without argonomic measures to conserve soil and water
   iv. Cultivation along susceptible banks
   v. Cultivation of erosion-permiting crops
   vi. Over-cropping without soil fertility replenishment
   vii. Faulty agricultural techniques
   viii. Excessive and Uncontrolled Grasslands
   ix. Unscientific mining and construction activities
   x. Intentional and accidental fires which result in loss of vegetation, organic matter and micro-organism.

8. State and breifly explain FOUR categories of drought. **(5 Marks)**
   i. Meteorological drought – it is usually defined on the basis of the degree of dryness and the duration of the dry period.
   ii. Agricultural drought – this links both hydrological and meteorological dought to agricultural impacts focusing on precipitation shortages, differences between actual and potential evapotranspiration, soil water deficits, reduced groundwater or reservoir levels and so forth.
   iii. Hydrological drought – is associated with effects of periods of precipitation including snowfall, shortfalls on surface or subsurface of water supply e.g., lake levels.
   iv. Hydrological with respect of the land use – although climate is a primary contributor to hydrological drought, other factors such as changes in land use e.g., deforestation, land degradation and the construction of dams all affect the hydrological characteristics of the basin.

SECTION B - ATTEMPT ANY TWO QUESTIONS - 20 Marks – (10 Marks each)

1. **A 12-hour storm rainfall with the following depths in cm occurred over a basin: 2.0, 2.5, 7.6, 3.8, 10.6, 5.0, 7.0, 10.0, 6.4, 3.8, 1.4 and 1.4. The surface runoff resulting from the above storm is equivalent to 25.5 cm of depth over the basin. Determine the average infiltration index (Φ-index) for the basin.**

   Solution:

   Φ-index = (rainfall-Runoff) / duration

   Total rainfall in 12 hours (p) = 61.5 cm

   Total runoff in 12 hours (R) = 25.5 cm

   Total infiltration in 12 hours = 61.5-25.5= 36 cm

   Average infiltration = 3.0 cm/hr

2. **The rainfall intensities for the successive1-hour period for 8-hrs storm is given as20,24,30,15,35,20,10,12 mm/hr ,if the total runoff is 80mm,determine the value of Φ-index.**

   Solution:

   Total rainfall = 20+24+30+15+35+20+10+12 =166mm

   Total runoff = 80mm

   Infiltration losses = Rainfall-Runoff = 166-80 =86mm

   Φ-index= (86/8) = 10.75 mm/hr = 1.075 cm/hr

3. **In a catchment area of 5km^2, the intensity of rainfall per hour for a 5hr duration storm are 10, 15, 20,22,5 mm. The volume of direct runoff is measured as 0.5cumec-day. Determine the Φ-index. For the catchment.**

   Solution:

   Total rainfall =72mm

   Average rate of rainfall (intensity of rainfall) = (72/5) = 14.4mm/hr.

   Total volume of rainfall over the catchment = (72 x 5x10^6)/ 1000

   = 360000m^3

   Total volume of runoff over the catchment = 0.5x 60 x60 x24

   =43200m^3

   Infiltration losses = Rainfall-Runoff =360000 -43200

   =316800m^3

   Depth of water over Catchment = (316800/ 5x10^6)

   =0.0633 m

   =63mm

   Φ-index=63/5

   =12.6mm/hr

WATER RESOURCE ENGINEERING FINAL EXAMINATION

SECTION C - ATTEMPT ANY ONE QUESTION - 10 Marks

1. **In a phreatic aquifer extending over 1 km^2 the watervtable was initially at 25m below ground level. Sometime after irrigation with a depth of 20cm of water, the water table rose to a depth of 24m bgl. Later 3x10^5 m^3 of water was pumped out and the water table dropped to 26.2 m bgl. Determine i) specific yield of the aquifer ii) deficit in soil moisture (below field capacity) before irrigation.**

Solution

Volume of water pumped out = Area of aquifer x drop in g.w.t x specific yield

$3x10^5$ = 10^6x2.2x Sy
Sy = **0.136 or 13.6%**

Volume of irrigation water recharging the aquifer = Area of aquifer xrise in g.w.t x Sy
Considering an area of 1m^2 of aquifer
1xy = 1x1x0.136
Recharge volume in terms of depth (y) = 0.136 m or 136 mm
Soil moisture deficit before irrigation = 200-136 = **64mm**

2. **In an area of 100 ha, the water table dropped by 4.5m. if the porosity is 30% and the specific retension is 10% determine i) the specific yield of the aquifre ii) change in groundwater storage.**

Solution
Porosity= Sy+ Sr
30%= Sy+ 10%
Sy= 20% or b0.2
Change in groundwater storage = area of aquifer x drop in gwtx Sy
= 100x4.5x0.2
= **90 ha-m or 90x10^4 m^3**