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AGRI. ENGINEERING

UPSC

INDIAN FOREST SERVICE

2026

Detailed Syllabus Based study material + Linkage of Concepts with PYQs + Infused with Infographics & Maps

Module 1

Paper 1 | Section A + B

PYQs summery

Chapter wise

INDIAN FOREST SERVICE (IFOS) 2023


AIR 01

Ritvika Pandey

Forestry Comprehensive Course


AIR 03

Swastic Yaduvanshi

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AIR 05

Vidyanshu Shekhar Jha

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AIR 28

Gaurav Saharan

Test Series


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Yash Singhal

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Nitish Pratik

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AIR 50

Vaasanthi P.

Test Series


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Atul Tiwari

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AIR 61

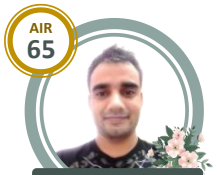
Sanket Adhao

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64 Out of 147 Total Selections in

Indian Forest Service (IFoS) 2023

AGRI. ENGINEERING

Paper – 1



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Module - 1

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CHAPTER

1

SOIL EROSION - FUNDAMENTALS

Mechanics of erosion · Rainfall & runoff · Hydrograph analysis · USLE & soil-loss models

OFFICIAL SYLLABUS – Chapter 1 Scope

UPSC IFoS — Agricultural Engineering, Paper I, Section A — Topic 1: Soil and Water Conservation

- **Chapter 1 covers: Mechanics and types of erosion (water & wind), their causes; rainfall, runoff and sedimentation; rainfall erosivity & soil erodibility; wind erosion process.**

Full Topic 1 syllabus (this Chapter 1 + later chapters in Module 1): Scope of soil and water conservation. Mechanics and types of erosion, their causes. Rainfall, runoff and sedimentation; rainfall erosivity and soil erodibility. Biological and engineering control measures (vegetative barriers, contour bunds, contour trenches, contour stone walls, contour ditches, terraces, outlets, grassed waterways). Gully control structures — temporary and permanent — design of permanent soil conservation structures (chute, drop, drop-inlet spillways). Design of farm ponds and percolation ponds. Flood routing. Watershed management — investigation, planning and implementation. Water harvesting and moisture conservation. Land development — levelling, estimation of earth volumes and costing. Wind erosion process. Design factors of shelter-belts and wind breaks. Forest (Conservation) Act.

SECTION A – UPSC IFoS Previous-Year Questions	*35 questions • 2016 – 2025*
2025	✎ Discuss the major types of precipitation storm. [P1/1(a) | 8M] ✎ Discuss the impacts of soil erosion on water quality. [P1/1(b) | 8M] ✎ Discuss the basic assumptions and steps involved in the development of unit hydrograph. [P1/1(c) | 8M] ✎ Explain the functional relationship of length of slope and degree of slope in the process of soil loss by water erosion. Discuss the methods of estimation of erosivity from rainfall data. [P1/2(a) | 10M] ✎ What are the factors that influence soil erodibility by wind? Discuss the impacts of different types of water erosion. [P1/2(b) | 15M]
2024	✎ Write a short note on the salient characteristics of precipitation on India. [P1/1(a) | 8M]
2023	✎ Explain the different processes involved in the development of gullies. [P1/1(b) | 8M] ✎ Determine the peak rate of runoff for a 10-year frequency from a watershed of 250 hectares, having weighted value of runoff coefficient (C) as 0·47. The distance from the remotest point in the watershed to the outlet is 3000 m and the elevation difference between the highest and outlet points of the watershed is 25 m. The maximum intensity-duration-frequency relationship

	of the watershed is given by i = (6·3117 × T^0·1523)/(D + 0·50)^0·945 where i = intensity in cm/h, T = return period in years and D = duration of rainfall in hours. [P1/2(b) | 10M] ✎ Explain the terms 'erodibility index' and 'roughness factor' used for prediction of wind erosion. [P1/3(a) | 10M]
2022	✎ Describe isohyetal method of estimating average rainfall depth over an area. Also write the advantages of it over arithmetic mean method. [P1/1(c) | 8M] ✎ What is a unit hydrograph? Write the uses and limitations of unit hydrograph. Explain the method for development of unit hydrographs of different durations by S-curve. [P1/2(b) | 15M]
2021	✎ Discuss in brief: (i) Sediment delivery ratio (ii) Stream channel erosion. [P1/1(b) | 8M] ✎ Define synthetic unit hydrograph and describe its derivation method. [P1/2(c) | 20M] ✎ Differentiate between the approaches of USLE and MUSLE models for soil loss and comment on their ranges of utility. [P1/3(a) | 10M]
2020	✎ Define drainage density and derive the relationship between drainage density and ruggedness number. [P1/1(c) | 8M] ✎ Determine the depth of runoff and peak rate of runoff for 25 years recurrence interval for antecedent moisture condition II from a 150-ha watershed. The curve number to apply for three 50 ha sub-watersheds for antecedent moisture condition II are respectively 85, 65 and 75. Six hours, 25 years frequency rainfall for the given location is 120 mm. The time of concentration and time to peak of runoff are 30 min and 60 min respectively. [P1/2(c) | 15M] ✎ The normal annual rainfall at Stations A, B, C, and D in the basin are 80·97, 67·59, 76·28 and 92·01 cm, respectively. In the year 1985, the Station D was inoperative and the Stations A, B and C recorded annual precipitation of 91·11, 72·33 and 79·89 cm, respectively. Estimate the rainfall at Station D in that year. [P1/3(b) | 10M] ✎ Discuss the methods of separation of base flow from a runoff hydrograph. [P1/3(c) | 20M]
2019	✎ Name different soil conservation regions of India with salient soil conservation problems in these regions. [P1/1(a) | 8M] ✎ What is universal soil loss equation? Explain in detail various parameters involved in the computation of soil loss using this equation. [P1/2(a) | 10M] ✎ Explain different methods for measurement of soil losses from agricultural watersheds (use diagrams wherever required). [P1/3(b) | 10M] ✎ Construct a hyetograph from the rainfall data provided in the table. [P1/4(c) | 10M] ✎ Compute the peak runoff rate of 15 years return period from a watershed area of 150 ha to design the field diversion. The sub-watersheds of 50 ha, 75 ha and 25 ha are kept under cultivation (c = 0·5), forest cover (c = 0·3) and grassland (c = 0·3), respectively. The other details are as follows: maximum length of watercourse = 2500 m; relief = 50 m; slope of watershed = 2·5%; watershed soil is clay; values of a, b, k and n are 0·1483, 0·50, 7·176 and 0·9459, respectively. [P1/4(d) | 10M]
2018	✎ What are the different types of runoff? Explain the factors that affect the runoff in a watershed. [P1/1(a) | 8M] ✎ Discuss the Rational method of predicting design peak runoff rate. In a watershed the most remote point is 600 m away from the outlet point. The outlet point is 3·0 m below the most remote point. Calculate the time of concentration of watershed. [P1/2(b) | 10M] ✎ Explain a procedure for checking rainfall data of a station for consistency. [P1/2(c) | 10M]

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	✎ The ordinates of the 2-h unit hydrograph of a watershed are given for hours 0 to 22. Determine the ordinates of S-curve hydrograph and using S-curve determine the ordinates of the 4-h unit hydrograph of watershed. [P1/3(a) | 10M] ✎ What are the factors which affect soil erosion by water? Discuss. If the degree of slope is increased 4 times, what will be the relative increase in erosion caused by water? [P1/3(b) | 10M]
2017	✎ Describe briefly, the SCS-CN method of runoff estimation. A watershed has 100 ha area. The watershed has 20 ha pasture in silty clay soil of 2% slope (CN = 65), 30 ha of pasture on silty loam soil of 0·5% slope (CN = 70) and remaining 50 ha of wheat crop on loam soil of 1% slope (CN = 85). Estimate the weighted curve number for the watershed. [P1/1(e) | 8M] ✎ What are rainfall Depth-Area-Duration (DAD) curves? Write down the step-by-step procedure for drawing Depth-Area-Duration curves. [P1/2(a) | 10M] ✎ Explain in brief, different types of erosion and their causes. [P1/2(b) | 10M]
2016	✎ What are the main causes of soil erosion in India? Explain the agronomic practices adopted for controlling the soil erosion. [P1/1(a) | 10M] ✎ Let P_1, P_2, P_3, …, P_n be the depths of rainfall recorded in n rain gauges enclosed by polygon having areas A_1, A_2, A_3, …, A_n within the watershed. Calculate the average depth of rainfall ($\bar{P}$) in the watershed of area A. [P1/1(c) | 10M] ✎ Define rational formula for estimating peak runoff rate. Why is it called rational? What are the limitations of rational formula? [P1/3(b) | 10M] ✎ What is water-stage recorder? Discuss the current meter as a water flow measuring device. [P1/4(b) | 10M]

SECTION B : State PSC Previous-Year Questions

40 questions • All states · year-descending

✎ What do you understand by soil erosion? Explain various types of water erosion.

UK·PSC **ACF/RFO/Logging Officer (Mains) 2025** | **Agri. Engineering** | **Q.1(I)** | 10M

✎ Factors affecting water erosion.

MH·PSC **Forest Services (Mains) 2024** | **Agri. Engineering** | **Q.1(a)** | 8M

✎ Biological measures to control soil erosion.

MH·PSC **Forest Services (Mains) 2024** | **Agri. Engineering** | **Q.1(e)** | 8M

✎ What is universal soil loss equation? How different factors in this equation are determined?.

MH·PSC **Forest Services (Mains) 2024** | **Agri. Engineering** | **Q.3(c)** | 10M

✎ The ordinates of a 4-h unit hydrograph are given below. If there is 4 cm and 6 cm of effective rainfall occurring uniformly for two consecutive 4-h intervals, calculate the direct runoff hydrograph.

OPSC·CSE **CSE (Main) 2024–25** | **Agri. Engineering** | **Paper-I, Q.7** | 15M

✎ What are the methods of estimation of rainfall erosivity factor?.

OPSC·CSE **CSE (Main) 2023–24** | **Agri. Engineering** | **Paper-I, Q.14(a)** | 20M

✎ Explain the components of the Universal Soil Loss Equation (USLE) in estimating soil loss. What are the limitations of using the USLE in watershed management?.

OPSC·CSE **CSE (Main) 2023–24** | **Agri. Engineering** | **Paper-I, Q.14(b)** | 20M

- Explain the SCS Curve Number (CN) method for estimating runoff in a watershed. What factors influence the CN value and runoff estimation?.

  OPSC·CSE CSE (Main) 2023–24 | Agri. Engineering | Paper-I, Q.17(b) | 20M

- How the soil erosion affects the agricultural land. Explain the different methods of soil erosion control measures.

  OPSC·Forest Forest Service (Main) 2023–24 | Agri. Engineering | Paper-I, Q.1(b) | 10M

- Explain about various runoff estimation methods.

  OPSC·CSE CSE (Main) 2022–23 | Agri. Engineering | Paper-I, Q.13(b) | 12M

- What is soil loss? Discuss about the estimation of soil loss using USLE equation.

  OPSC·CSE CSE (Main) 2022–23 | Agri. Engineering | Paper-I, Q.15(b) | 12M

- What is the purpose of estimating peak runoff rate? Describe the rational formula and its limitations for estimating peak runoff rate.

  UK·PSC RFO (Mains) 2021 | Agri. Engineering | Q.1(i) | 10M

- Classify the factors influencing soil erosion by wind. Briefly describe the wind break and shelter belts practices for controlling wind erosion.

  UK·PSC RFO (Mains) 2021 | Agri. Engineering | Q.1(iv) | 10M

- Following are the ordinates of direct runoff of 2.5 cm effective rainfall of 3-h duration. Determine the ordinates of 3- h unit hydrograph:.

  OPSC·CSE CSE (Main) 2020–21 | Agri. Engineering | Paper-I, Q.5(c),(ii) | 12M

- Calculate the soil erodibility factor (K) for use in universal soil loss equation, using the following information :.

  OPSC·CSE CSE (Main) 2020–21 | Agri. Engineering | Paper-I, Q.6(c),(ii) | 12M

- Explain the universal soil loss equation.

  OPSC·CSE CSE (Main) 2020–21 | Agri. Engineering | Paper-I, Q.7(d) | 12M

- Flow Chart - Multimedia - Hardware and Software - Computer Networks - Applications of Computer - Enumerate how soil erosion affects agriculture. Explain different types of soil erosion. How soil loss is estimated by Universal Soil Loss Equation? What is its revised form?.

  OPSC·Forest Forest Service (Main) 2019–20 | Agri. Engineering | Paper-I, Q.1(a) | 20M

- Describe the on-site and off-site impacts of soil erosion.

  AP·PSC RFO (Mains) 2018 | Agri. Engineering | Q.1(a) | 4M

- Compare the differences between water and wind erosion in terms of sediment transport.

  AP·PSC RFO (Mains) 2018 | Agri. Engineering | Q.1(b) | 6M

- Discuss the main reasons for the high rates of soil erosion in some regions and low in others.

  AP·PSC RFO (Mains) 2018 | Agri. Engineering | Q.1(c) | 6M

- Describe factors affecting soil erodibility.

  AP·PSC RFO (Mains) 2018 | Agri. Engineering | Q.1(d) | 4M

- Describe in brief about stream bank erosion.

  AP·PSC RFO (Mains) 2018 | Agri. Engineering | Q.2(c) | 5M

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- What would be the impacts of corn monocropping for biofuel production on soil erosion and long-term soil productivity?.

  AP·PSC RFO (Mains) 2018 | Agri. Engineering | Q.3(b) | 6M

- Describe the mechanisms responsible for the reduction of soil erosion by adding animal manure to the soil surface.

  AP·PSC RFO (Mains) 2018 | Agri. Engineering | Q.3(c) | 4M

- How will you select a site for a raingauge station?.

  OPSC·CSE CSE (Main) 2018–19 | Agri. Engineering | Paper-I, Q.5(a),(iii) | 5M

- | --- | --- | --- | --- | --- | | 16 | 00 | 16 | 05 | 0.0 | 9.5 | | 16 | 05 | 16 | 15 | 9.5 | 18.5 | | 16 | 15 | 16 | 22 | 18.5 | 27.5 | | 16 | 22 | 16 | 30 | 27.5 | 36.5 | | 16 | 30 | 16 | 50 | 36.5 | 39.5 | | 16 | 50 | 17 | 20 | 39.5 | 41.4 | - Write on the characteristics of the raindrops that are important from soil erosion point of view.

  OPSC·CSE CSE (Main) 2018–19 | Agri. Engineering | Paper-I, Q.6(b) | 10M

- Present the critique of the vegetative and mechanical measures to control soil erosion.

  OPSC·CSE CSE (Main) 2016–17 | Agri. Engineering | Paper-I, Q.7(a) | 15M

- Explain, in brief, the SCS curve number technique (Hydrological Soil Cover Complex Method) of estimation of surface runoff from small agricultural watersheds.

  OPSC·CSE CSE (Main) 2016–17 | Agri. Engineering | Paper-I, Q.8(a) | 15M

- Coefficient of storage - Area of influence - Give the procedure for estimation of runoff volume by curve number method.

  OPSC·CSE CSE (Main) 2015–16 | Agri. Engineering | Paper-I, Q.5(b),(i) | 10M

- Discuss on the various factors affecting runoff.

  OPSC·CSE CSE (Main) 2015–16 | Agri. Engineering | Paper-I, Q.5(b),(ii) | 10M

- Discuss briefly on the different types of water erosion.

  OPSC·CSE CSE (Main) 2015–16 | Agri. Engineering | Paper-I, Q.5(c),(i) | 10M

- Describe, with the help of neat sketch, any three methods of separation of base flow from the hydrograph of runoff indicating the situations under which the methods are suitable.

  OPSC·CSE CSE (Main) 2015–16 | Agri. Engineering | Paper-I, Q.1(c) | 20M

- Draw a single peaked hydrograph and indicate its various components.

  OPSC·CSE CSE (Main) 2015–16 | Agri. Engineering | Paper-I, Q.4(b) | 10M

- Define Runoff and explain the rational method of computing the peak discharge of small catchment.

  OPSC·Forest Forest Service (Main) 2015–16 | Agri. Engineering | Paper-I, Q.2(c) | 10M

- Tabulated are the data derived from a drainage basin. Determine the average depth of rainfall using Thiessen polygon method:.

  OPSC·Forest Forest Service (Main) 2015–16 | Agri. Engineering | Paper-I, Q.3(b) | 10M

- | --- | --- | | A | 26.9 | 108 | | B | 15.4 | 35 | | C | 28.2 | 18 | | D | 19.2 | 110 | | E | 14.6 | 107 | | F | 6.5 | 71 | | G | 29.8 | 83 | | H | 45.0 | 66 | | I | 50.0 | 12 | | J | 19.7 | 9 | - What are the ill effects of water erosion? Describe, in brief, the various forms of water erosion.

OPSC·Forest Forest Service (Main) 2015–16 | Agri. Engineering | Paper-I, Q.3(c) | 10M

- A 3 hour storm occurred at a place and the precipitations in the neighboring rain-gauge stations P, Q and R were measured as 3.8, 4.1 and 4.5 cm, respectively. The precipitation in the neighboring staion S could not be measured since the rain gauge bottle was broken. The normal precipitations in the four stations P, Q, R and S as per IMD Bulletin were 45, 48, 53 and 50 cm, respectively. Estimate the storm precipitation at station S.

  OPSC·Forest Forest Service (Main) 2015–16 | Agri. Engineering | Paper-I, Q.4(a) | 10M

- Derive the Hooghoudts equation for constant ground water table at uniform rate of irrigation or rainfall. Enlist the required assumptions for the derivation.

  OPSC·Forest Forest Service (Main) 2015–16 | Agri. Engineering | Paper-I, Q.5(a) | 20M

- Derive the curve number equation used for the determination of excess runoff from its basic principle? Also discuss its limitation.

  AP·PSC RFO (Mains) 2012 | Agri. Engineering | Q.7 | 40M

- Explain various phases of wind erosion process, and different factors involved in estimation of soil loss by wind.

  UK·PSC RFO (Mains) 2012 | Agri. Engineering | Q.1(i) | 10M

SECTION C — Year × Source Heatmap

Dark = high frequency · Light = low frequency

SOURCE \ YEAR	25	24-25	24	23-24	23	22-23	22	21	20-21	20	19-20	19	18-19	18	17	16-17	16	15-16	12	TOTAL
IFoS	5	·	1	·	3	·	2	3	·	4	·	5	·	5	3	·	4	·	·	35
OPSC·CSE	·	1	·	3	·	2	·	·	3	·	·	·	2	·	·	2	·	5	·	18
OPSC·Forest	·	·	·	1	·	·	·	·	·	·	1	·	·	·	·	·	·	5	·	7
MH·PSC	·	·	3	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	3
UK·PSC	1	·	·	·	·	·	·	2	·	·	·	·	·	·	·	·	·	·	1	4
HP·PSC	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	0
AP·PSC	·	·	·	·	·	·	·	·	·	·	·	·	·	7	·	·	·	·	1	8

HOT SUBTOPICS — Most-asked themes in Chapter 1

- Soil Erosion (water/wind, mechanics, types) *(31 questions)*
- Runoff & Peak-flow Estimation *(19 questions)*
- Rainfall & Precipitation Analysis *(17 questions)*
- Unit Hydrograph & Hydrology *(10 questions)*
- USLE / MUSLE / Soil-loss models *(8 questions)*
- SCS-CN / Curve Number Method *(6 questions)*

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CHAPTER

2

SOIL CONSERVATION MEASURES

Mechanical structures · Vegetative barriers · Shelter belts · Land-use capability

OFFICIAL SYLLABUS – Chapter 2 Scope

UPSC IFoS — Agricultural Engineering, Paper I, Section A — Topic 1: Soil and Water Conservation

- **Chapter 2 covers** : Biological & engineering soil-erosion control measures — vegetative barriers, contour bunds, contour trenches, contour stone walls, contour ditches, terraces, outlets and grassed waterways. Wind-erosion control: shelter-belts and wind breaks. Agronomic and tillage practices for erosion control. Land-use capability classification.

Full Topic 1 syllabus (this Chapter 2 + sister chapters in Module 1): Scope of soil and water conservation. Mechanics and types of erosion, their causes. Rainfall, runoff and sedimentation; rainfall erosivity and soil erodibility. Biological and engineering control measures (vegetative barriers, contour bunds, contour trenches, contour stone walls, contour ditches, terraces, outlets, grassed waterways). Gully control structures — temporary and permanent — design of permanent soil conservation structures (chute, drop, drop-inlet spillways). Design of farm ponds and percolation ponds. Flood routing. Watershed management — investigation, planning and implementation. Water harvesting and moisture conservation. Land development — levelling, estimation of earth volumes and costing. Wind erosion process. Design factors of shelter-belts and wind breaks. Forest (Conservation) Act.

SECTION A – UPSC IFoS Previous-Year Questions	*30 questions • 2016 – 2025*
2025	✎ Write down the principles to be adopted while calculating the spacing of bunds (contour and graded bunds). Also, calculate the height of the bunds, if the distance between the bunds is expressed by L, vertical interval between the bunds is expressed by V, width of water spread is expressed by W and land slope is expressed by S percent. Assume the maximum rainfall amount which has to stand behind the bund as 15 cm. [P1/3(c) | 15M]
2024	✎ State the adoptability and functions of conservation ditches and contour stone wall used for control of soil erosion. [P1/1(c) | 8M] ✎ Discuss in brief about vegetative management and tillage practices used for control of erosion by wind. [P1/1(b) | 8M] ✎ Discuss in brief about the main objectives, their types, limitation in use and precautionary measures to avoid failure of terraces — a soil erosion control measure. [P1/2(b) | 10M]
2023	✎ Discuss in brief 'wattling — an erosion control measure'. [P1/1(a) | 8M] ✎ Derive the expression for area lost in percentage for cultivation due to construction of bench terrace under the following conditions: (i) Batter slope 1 : 1 (ii) Batter slope ½ : 1. [P1/2(c) | 20M]

	✎ Design a grass waterway with trapezoidal cross-section for the following data: (i) Peak rate of runoff, Q = 4·0 m^3/s (ii) Grade to be used = 0·3% (iii) Manning's roughness coefficient = 0·04 (iv) Side slope, Z = 2 : 1 (H : V). Assume other necessary data. [P1/3(b) | 15M]
2022	✎ Discuss soil conservation farming practices recommended for lands under land use capability classification Class II. [P1/2(a) | 15M] ✎ Calculate the design dimensions of a contour bund in a medium deep soil having an average slope of 3%. The maximum expected rainfall during a 10-year recurrence is 20 cm. The infiltration capacity of the soil in the area is such that 30 percent of the rain infiltrates into the soil. The horizontal interval between bunds is 60 m. Assume slope of seepage line to be 4 : 1 and side slope of bund to be 1·5 : 1. [P1/2(c) | 10M] ✎ A 200 m long graded bund is laid out at a slope of 0·4%. The height of the graded bund having trapezoidal channel was measured to be 45 cm. The bottom width of the channel was 2 m and the side slopes were 5 : 1 each. Determine maximum runoff for which the channel was designed. The free board is 15 cm. Had the channel been triangular with the same side slope, what would have been the ridge height to discharge the same discharge? Assume n = 0·04. [P1/3(c) | 10M]
2021	✎ Differentiate between continuous contour trench and staggered contour trench. [P1/1(a) | 8M] ✎ Discuss in brief about contour strip cropping, field strip cropping and buffer strip cropping used for conserving soil and water in a cultivated field. [P1/2(a) | 10M] ✎ Calculate the spacing between the shelter-belt having a height of 15 m. The actual wind velocity at 15 m height is 18 kmph and threshold wind velocity at 15 m height is 9 kmph. The angle of deviation of prevailing wind direction perpendicular to the wind break is 10 degrees. [P1/2(b·i) | 10M]
2019	✎ Explain different types of engineering measures of soil erosion control. Mention the design criteria of contour bund. [P1/1(b) | 8M] ✎ Design a parabolic-shaped waterway to carry a flow of 3 m^3/sec down a slope of 4 percent. An excellent stand of dub grass is to be maintained in the waterway. Assume the necessary data required for calculation and draw a parabolic cross-section. The maximum flow velocity allowed is 2·5 m/sec. [P1/1(e) | 8M] ✎ Calculate the height of contour bund to be constructed on a land slope of 5 percent. Assume the following: (i) Rainfall excess for 24 hours duration is 80 cm (ii) 15 m is horizontal interval (iii) Depth of water flow over the weir is 30 cm. [P1/2(d) | 10M] ✎ Write about design factors and layout to install shelter-belt against wind erosion. [P1/3(a) | 10M] ✎ Write short notes on: (i) Grassed waterway (ii) Nalla bunding (iii) Movement of soil particles in wind erosion (iv) Vegetative measures for soil erosion control (v) Rational method for estimating runoff. [P1/4(b) | 10M]
2018	✎ What do you understand by biological or vegetative measures in a watershed? Describe the measures. [P1/1(b) | 8M] ✎ What is contour trench? Write about different types of contour trenches. Explain design procedure of contour trench systems. [P1/2(d) | 10M] ✎ Describe the classification of bench terraces given by Rama Rao and Bali, with suitable sketches. [P1/4(a) | 10M]
2017	✎ Write the step-by-step procedure for planning and design of a graded bunding. [P1/3(a) | 10M]

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	✎ Design a grassed waterway of parabolic shape to carry a flow of 2·6 m^3/s, down a slope of 3%. The waterway has a good stand of grass and velocity of 1·75 m/s can be allowed. Assume the value of Manning's roughness coefficient 'n' as 0·04. [P1/3(b) | 10M] ✎ Write short notes on the following: (i) Universal Soil Loss Equation (ii) Catchment Area Treatment (iii) Agronomic Erosion Control Measures (iv) Functions and Planning of Terraces (v) Elements of Flood Routing. [P1/4(b) | 10M] ✎ It is planned to construct bench terraces on a 20% hill slope. If the vertical interval is 2 m, determine: (i) Length per hectare (ii) Earthwork (iii) Area lost, both for vertical cut and batter slope of 1 : 1. (The cut should be equal to fill). [P1/4(c) | 10M]
2016	✎ What are the contour and graded bunds? How do they differ in design and functional aspects?. [P1/1(b) | 10M] ✎ Calculate the cross-section of a contour bund used to store 24-hour excess rainfall of 10 cm. The annual rainfall is about 120 cm with a high intake rate and there is low coverage of crops over the land. The land slope is 4%. Use Cox's formula for VI of contour bund. [P1/1(d) | 10M] ✎ Design the dimensions of a weir used to discharge excess runoff through a contour bund for the conditions given: Land slope = 1·5%, Top width of the bund = 45 cm, Height of the bund = 60 cm, Height of crest above GL = 30 cm, Side slope of the bund = 2 : 1, VI = 1 m, Length of the bund = 400 m, Intensity of rainfall for the return period and time of concentration = 12 cm/hr. During the peak rainfall constant infiltration rate = 2·5 cm/hr. No water is stored behind the bund before the peak rainfall occurs. Determine the volume of water stored behind the bund before it starts flowing. [P1/2(c) | 20M] ✎ Design a 150 m long inward sloping (5%) bench terrace for a sandy loam soil with an average slope of 15%. The entire width of the terrace acts as a channel which is provided with a uniform grade of 0·6%. The rainfall intensity for the return period and time of concentration is 20 cm/hr, runoff coefficient = 0·3, riser side slope = 1 : 1, shoulder bund height = 30 cm, bottom width = 75 cm, side slope = 1 : 1, Manning's n = 0·04, VI = 1·06 m, area of the terrace = 0·09 ha. [P1/3(c) | 20M] ✎ Design a parabolic shaped grassed waterway to carry a flow of 3 cu m/s down a slope of 4%. An excellent stand of dub grass is to be maintained in the waterway. Take Manning's n = 0·04. [P1/4(c) | 20M]

SECTION B – State PSC Previous-Year Questions	*15 questions • All states · year-descending*
✎ What is bench terracing? What are objectives and limitations of bench terracing? Give types of bench terraces along with its suitability. **MH·PSC** **Forest Services (Mains) 2024 | Agri. Engineering | Q.2(a) |** 15M	
✎ Design a parabolic-shaped grassed waterway to carry the peak flow of 6 m3/s on a 1% slope on erodible sandy soil. The waterway must have good grass cover and a permissible flow velocity of 1.5 m/s can be allowed. Assume the value of Manning's coefficient as 0-034. **OPSC·CSE** **CSE (Main) 2023–24 | Agri. Engineering | Paper-I, Q.15(b) |** 20M	
✎ Write the different method of bunds to control soil. erosion. Explain the design criteria and specification of contour bund.	

OPSC·Forest **Forest Service (Main) 2023–24** | **Agri. Engineering** | **Paper-I, Q.1(c)** | 10M

- Write about the land capability classification.

  OPSC·CSE **CSE (Main) 2022–23** | **Agri. Engineering** | **Paper-I, Q.17(a)** | 8M

- What is bench terracing? Classify the bench terraces based on purpose and slope of bench.

  HP·PSC **RFO (Mains) 2021** | **Agri. Engineering** | **Q.1(b)** | 10M

- Classify the factors influencing soil erosion by wind. Briefly describe the wind break and shelter belts practices for controlling wind erosion.

  UK·PSC **RFO (Mains) 2021** | **Agri. Engineering** | **Q.1(iv)** | 10M

- Calculate the spacing and length of contour bund for a medium rainfall area on 4 ha, if land of area has 5% slope.

  OPSC·CSE **CSE (Main) 2020–21** | **Agri. Engineering** | **Paper-I, Q.6(b),(ii)** | 12M

- Describe the land capability classification. Explain its various components, conservation measures, suitability and limitations of each classes and sub-classes.

  OPSC·CSE **CSE (Main) 2020–21** | **Agri. Engineering** | **Paper-I, Q.6(c),(i)** | 8M

- Discuss the differences among inter-cropping, contour cropping, and strip cropping in relation to design and erosion control effectiveness.

  AP·PSC **RFO (Mains) 2018** | **Agri. Engineering** | **Q.3(a)** | 10M

- A contour bund is to be constructed on a land with 2.5% slope. The vertical interval is 1.5m and the area receives maximum rainfall of 10cm for a 10 year recurrence period. One fourth of the rainfall is lost as surface runoff. The bund side slope is 1.5 : 1; a free board of 10% of bund height is to be provided. Design the bund size and also determine the percentage area lost due to bunds. Assume the slope of the seepage line to be 4:1. 30.

  OPSC·CSE **CSE (Main) 2018–19** | **Agri. Engineering** | **Paper-I, Q.7(a)** | 30M

- Discuss. in detail the land capability classification. Write if you know any modifications in it under Indian conditions.

  OPSC·CSE **CSE (Main) 2017–18** | **Agri. Engineering** | **Paper-I, Q.7(a)** | 15M

- Describe the land use capability classification in Indian conditions and in your state.

  OPSC·CSE **CSE (Main) 2016–17** | **Agri. Engineering** | **Paper-I, Q.5(c)** | 20M

- Differentiate between contour strip cropping, field strip cropping and buffer strip cropping for conserving soil and water in a cultivated field.

  UK·PSC **RFO (Mains) 2015** | **Agri. Engineering** | **Q.1(ii)** | 10M

- When do you recommend contour and graded bund?.

  AP·PSC **RFO (Mains) 2012** | **Agri. Engineering** | **Q.1(H)** | 4M

- When do you recommend biological measures for soil conservation? Distinguish between field strip cropping and buffer cropping.

  AP·PSC **RFO (Mains) 2012** | **Agri. Engineering** | **Q.2(J)** | 5M

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SECTION C — Year × Source Heatmap											*Dark = high frequency · Light = low frequency*	
SOURCE \ YEAR	25	24	23	22	21	19	18	17	16	15	12	TOTAL
IFoS	1	3	3	3	3	5	3	4	5	·	·	30
OPSC·CSE	·	1	1	·	2	1	1	1	·	·	·	7
OPSC·Forest	·	1	·	·	·	·	·	·	·	·	·	1
MH·PSC	·	1	·	·	·	·	·	·	·	·	·	1
UK·PSC	·	·	·	·	1	·	·	·	·	1	·	2
HP·PSC	·	·	·	·	1	·	·	·	·	·	·	1
AP·PSC	·	·	·	·	·	·	1	·	·	·	2	3

HOT SUBTOPICS — Most-asked themes in Chapter 2

- Contour & Graded Bunds *(10 questions)*
- Grassed Waterways *(5 questions)*
- Vegetative & Agronomic Measures *(5 questions)*
- Land-U
- se Capability Classification *(5 questions)*
- Bench Terraces *(4 questions)*
- Contour Trenches & Stone Walls *(3 questions)*

CHAPTER

3

GULLY CONTROL & PERMANENT STRUCTURES

Drop · chute · drop-inlet spillways · check dams · farm ponds · stability of structures

OFFICIAL SYLLABUS – Chapter 3 Scope

UPSC IFoS — Agricultural Engineering, Paper I, Section A — Topic 1: Soil and Water Conservation

- **Chapter 3 covers:** Gully control structures (temporary and permanent). Design of permanent soil-conservation structures — drop spillway, chute spillway and drop-inlet pipe spillway. Design of farm ponds and percolation ponds. Stability analysis of retention walls and dams. Wing walls, levees, retards and waste weirs. Design of trickle and flood spillways for earth dams.

Full Topic 1 syllabus (this Chapter 3 + sister chapters in Module 1): Scope of soil and water conservation. Mechanics and types of erosion, their causes. Rainfall, runoff and sedimentation; rainfall erosivity and soil erodibility. Biological and engineering control measures (vegetative barriers, contour bunds, contour trenches, contour stone walls, contour ditches, terraces, outlets, grassed waterways). Gully control structures — temporary and permanent — design of permanent soil conservation structures (chute, drop, drop-inlet spillways). Design of farm ponds and percolation ponds. Flood routing. Watershed management — investigation, planning and implementation. Water harvesting and moisture conservation. Land development — levelling, estimation of earth volumes and costing. Wind erosion process. Design factors of shelter-belts and wind breaks. Forest (Conservation) Act.

SECTION A – UPSC IFoS Previous-Year Questions	*22 questions • 2016 – 2025*
2025	✎ Discuss the requirements and essential features of trickle spillway and flood spillway in an earth dam. [P1/1(d) | 8M] ✎ (i) A watershed has an area of 1000 hectares and an average slope of 1·5%. The average 30-year, 24-hour duration rainfall is 76·2 mm, while the runoff volume calculated by the curve number technique is 31·4 mm. The length to width ratio is 3·5 : 1. Determine time to peak and peak discharge. [10M] (ii) Determine the size of each side of a square box inlet for a drop spillway to handle a peak flow of 3·2 cumecs over a fall of 1·5 m, if the energy head to fall ratio is not to exceed 0·6 at any time. [5M]. [P1/2(c) | 15M]
2024	✎ Design a drop spillway to be constructed at a place in a gully having width of 5 m and drainage area of 58 ha. The net drop is 2 m. Take the rainfall intensity for duration equal to time of concentration of watershed and design return period of 25 years, as 120 mm/h. The coefficient of runoff for a watershed is 0·3. The structure is to be constructed in stone masonry. [P1/2(c) | 20M] ✎ Calculate the capacity of a pond having the area enclosed by different contours as given. [P1/3(b) | 15M]
2023	✎ Discuss the purpose, advantages and limitations of percolation tank. [P1/1(c) | 8M]

	✎ Determine the height of wing wall of a drop structure if the (i) net drop from the top of transverse sill to the crest (F) = 2·50 m; (ii) head over the crest (h) = 1·50 m; (iii) height of transverse sill (S) = 0·50 m. [P1/3(c) | 15M]
2022	✎ What is a check dam? Write the uses of check dams. Explain planning and design procedure of check dams. [P1/3(a) | 15M]
2021	✎ A drop inlet pipe spillway is designed for 3 m^3/s peak flow and 4 m total head. The length of the pipe is 10 m. The entrance and friction loss coefficients are 0·04 and 0·025, respectively. Calculate the cross-sectional area of the pipe. [P1/2(b·ii) | 10M] ✎ Write down the objectives of drop spillway. Discuss the advantages and limitations of drop spillway. Describe the procedure for design of drop spillway. [P1/3(c) | 20M]
2020	✎ State the adaptability and functions of the following structures: (i) Drop spillway (ii) Chute spillway (iii) Levees (iv) Retards. [P1/1(a) | 8M] ✎ Calculate the volume of water available in the pond under the following conditions: (i) When the pond is filled to 100% of its total depth. (ii) When the pond is filled to 50% of its total depth. The dimensions of the pond are: Shape — Trapezoidal, Depth 3·0 m, Side slope 2 : 1 (H : V), Bottom surface 21 m × 45 m. [P1/2(b) | 15M]
2019	✎ Explain the stability analysis of retention walls and dams. [P1/1(d) | 8M] ✎ Explain the measures for controlling gully formation. [P1/2(b) | 10M] ✎ Explain different types of spillways used in gully control. Compare the structural and design features of these spillways. [P1/3(c) | 10M] ✎ Calculate the volume of excavation required to construct a dugout farm pond, if (i) average depth of the pond is 5·0 m; (ii) bottom width is 15·0 m; (iii) side slope to be used is 2 : 1; (iv) bottom length is 25·0 m. [P1/3(d) | 10M]
2018	✎ Discuss design procedure of permanent soil conservation structures. [P1/3(d) | 10M] ✎ Discuss in brief the utility of farm ponds. What are the different types of ponds depending upon the source of water and their location with respect to land surface? Write the criteria for selection of site of farm ponds. [P1/4(c) | 10M]
2017	✎ Design a waste weir using the following data: Cumulative catchment area = 35 ha; Flood depth over the crest of weir = 0·6 m; Intensity of rainfall = 50 mm/hr; Runoff coefficient = 0·5. [P1/2(d) | 10M] ✎ Discuss the functions, limitations and design features of chute spillways. [P1/3(c) | 10M] ✎ What are the different types of farm ponds and their essential design requirements?. [P1/3(d) | 10M] ✎ Discuss different methods of Gully Control. Explain the steps followed in the design of gully control structures. [P1/4(d) | 10M]
2016	✎ With a neat sketch, explain the working of drop inlet spillway. Under what situation is it preferred? [P1/2(a) | 10M]

SECTION B – State PSC Previous-Year Questions	*18 questions • All states · year-descending*
✎ What are the main differences among drop spillway, chute spillway and drop-inlet spillway? Annual average soil loss from a watershed has been measured as 20 tha.year. The watershed has 8% land slope	

and 84 m maximum slope length. Assume all other factors same and dimensionless exponent for slope factor = 0.5. What should be the maximum slope length to reduce the annual average soil loss from the watershed to 10 tha.year.?.

OPSC·CSE **CSE (Main) 2024–25** | **Agri. Engineering** | **Paper-I, Q.9** | 15M

- What is gully erosion? Discuss the stages and classification of gullies. Enumerate the conditions under which permanent gully control structures are recommended.

  OPSC·CSE **CSE (Main) 2024–25** | **Agri. Engineering** | **Paper-I, Q.13** | 20M

- Define farm pond and mention its purposes. Explain the process to calculate the capacity of a farm pond using contours. A hill slope having 15% slope is to be provided with bench terraces. The vertical interval of the terraces should be 1.5 m. Determine the length of the terrace and the earthwork per ha. What will be the area lost, if the batter slope given is 1 : 1?.

  OPSC·CSE **CSE (Main) 2024–25** | **Agri. Engineering** | **Paper-I, Q.18** | 20M

- Describe the components of farm pond. Explain the design criteria of farm pond.

  OPSC·Forest **Forest Service (Main) 2023–24** | **Agri. Engineering** | **Paper-I, Q.2(b)** | 20M

- Explain permanent gully control structures with neat sketch.

  OPSC·CSE **CSE (Main) 2022–23** | **Agri. Engineering** | **Paper-I, Q.15(a)** | 8M

- Explain the steps involved in designing of farm pond, uses of farm pond and percolation pond.

  OPSC·CSE **CSE (Main) 2022–23** | **Agri. Engineering** | **Paper-I, Q.16(a)** | 8M

- What are the main functions of permanent soil conservation structures? When is drop spillway required to be constructed and how does it differ from chute spillway?.

  UK·PSC **RFO (Mains) 2021** | **Agri. Engineering** | **Q.1(ii)** | 10M

- Calculate the capacity of a farm pond and having the area enclosed by different contours as follows (Contour interval 1m):.

  OPSC·CSE **CSE (Main) 2020–21** | **Agri. Engineering** | **Paper-I, Q.5(b),(ii)** | 12M

- Temporary gully control measures.

  OPSC·CSE **CSE (Main) 2020–21** | **Agri. Engineering** | **Paper-I, Q.5(d),(ii)** | 5M

- Differentiate between drop spillway and drop inlet pipe spillway. Under what conditions they are recommended?.

  OPSC·CSE **CSE (Main) 2018–19** | **Agri. Engineering** | **Paper-I, Q.5(b),(ii)** | 10M

- Enumerate the conditions under which permanent gully control structures are recommended. Illustrate your answer with suitable examples and proper diagrams.

  OPSC·CSE **CSE (Main) 2018–19** | **Agri. Engineering** | **Paper-I, Q.8(a)** | 20M

- A straight gravity masonry dam of trapezoidal section has a top width of 1.6 m, base width of 3.2 m and a height of 6.2 m. the water impounding height is 5.6 m. the coefficient of friction is 0.5, the bearing capacity of soil is 25,000 kg/m2. Test the structural stability of the dam.

  OPSC·CSE **CSE (Main) 2016–17** | **Agri. Engineering** | **Paper-I, Q.7(c)** | 30M

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- Chute spillway - Drop spillway - Discuss briefly the applications of remote sensing and GIS in water resources development.

  OPSC·CSE CSE (Main) 2015–16 | Agri. Engineering | Paper-I, Q.7(b),(ii) | 10M

- Classify soil conservation structures into various categories. Draw a neat diagram of a drop spillway. Label and describe functions of various parts of the drop spillway structure.

  OPSC·Forest Forest Service (Main) 2015–16 | Agri. Engineering | Paper-I, Q.3(a) | 10M

- List the various types of farm pond. Describe the embankment type of farm pond and write the formula used for calculation of top width of the pond.

  OPSC·Forest Forest Service (Main) 2015–16 | Agri. Engineering | Paper-I, Q.6(b) | 10M

- Describe the purpose of various structural components of a drop spillway with the help of neat sketch.

  UK·PSC RFO (Mains) 2015 | Agri. Engineering | Q.1(iii) | 10M

- Explain the temporary structures for gully control. Also describe the suitability criteria for designing various types of check dams with the help of diagrams.

  UK·PSC RFO (Mains) 2012 | Agri. Engineering | Q.1(ii) | 10M

- Explain the functions, advantages and limitations of a drop spillway. Also, draw a neat diagram of a straight-inlet drop spillway and label its parts.

  UK·PSC RFO (Mains) 2012 | Agri. Engineering | Q.2(i) | 10M

SECTION C – Year × Source Heatmap

Dark = high frequency · Light = low frequency

SOURCE \ YEAR	25	24	23	22	21	20	19	18	17	16	15	12	TOTAL
IFoS	2	2	2	1	2	2	4	2	4	1	·	·	22
OPSC·CSE	3	·	2	·	2	·	2	·	1	1	·	·	11
OPSC·Forest	·	1	·	·	·	·	·	·	·	2	·	·	3
MH·PSC	·	·	·	·	·	·	·	·	·	·	·	·	0
UK·PSC	·	·	·	·	1	·	·	·	·	·	1	2	4
HP·PSC	·	·	·	·	·	·	·	·	·	·	·	·	0
AP·PSC	·	·	·	·	·	·	·	·	·	·	·	·	0

HOT SUBTOPICS – Most-asked themes in Chapter 3

Frequency bars scaled to top topic (11 questions)

- Drop Spillway — **11** *Qs*
- Gully Control Methods — **10** *Qs*
- Chute & Drop-Inlet Spillways — **7** *Qs*
- Farm Ponds & Percolation Tanks — **7** *Qs*
- Trickle & Flood Spillways — **2** *Qs*
- Check Dams — **2** *Qs*
- Wing & Retention Walls — **1** *Qs*

CHAPTER

4

FLOOD CONTROL, WATERSHED MGMT & LAND DEVELOPMENT

Watershed planning · Water harvesting · Flood routing · Land grading · Drought · Sand dunes

OFFICIAL SYLLABUS – Chapter 4 Scope

UPSC IFoS — Agricultural Engineering, Paper I, Section A — Topic 1: Soil and Water Conservation

- **Chapter 4 covers:** Flood routing (Muskingum method), storage and detention reservoirs. Watershed management — investigation, planning, prioritization and implementation; integrated watershed approach; stream ordering. Water harvesting and moisture conservation (in-situ + ex-situ) for dryland and non-arable areas. Land development — levelling, plane method, factors and survey for land grading; estimation of earth volumes and costing. Drought management. Sand-dune fixation. Watershed development programmes (Hariyali, WARASA-Jan Sahbhagita). Wind-erosion process — soil-particle movement and surface wind-velocity reduction.

Full Topic 1 syllabus (this Chapter 4 + sister chapters in Module 1): Scope of soil and water conservation. Mechanics and types of erosion, their causes. Rainfall, runoff and sedimentation; rainfall erosivity and soil erodibility. Biological and engineering control measures (vegetative barriers, contour bunds, contour trenches, contour stone walls, contour ditches, terraces, outlets, grassed waterways). Gully control structures — temporary and permanent — design of permanent soil conservation structures (chute, drop, drop-inlet spillways). Design of farm ponds and percolation ponds. Flood routing. Watershed management — investigation, planning and implementation. Water harvesting and moisture conservation. Land development — levelling, estimation of earth volumes and costing. Wind erosion process. Design factors of shelter-belts and wind breaks. Forest (Conservation) Act.

SECTION A – UPSC IFoS Previous-Year Questions	*28 questions • 2016 – 2025*
2025	✎ What are the principles and objectives of watershed management? Discuss the criteria used for prioritizing watersheds. [P1/3(a) | 15M] ✎ Discuss in brief about compartmental bunding, intra-plot water harvesting, ridge furrow planting and field bunding methods used for in-situ water harvesting and moisture conservation. Enlist the ex-situ methods of water harvesting. [P1/3(b) | 10M]
2024	✎ Discuss in brief about storage reservoirs and detention reservoirs methods adopted for control of floods. [P1/1(d) | 8M] ✎ Differentiate between the approaches of 'WARASA – Jan Sahbhagita' and 'Hariyali', the watershed development programmes. [P1/2(a) | 10M] ✎ Explain the criteria for land levelling design. [P1/3(a) | 10M]

	✎ What is the basic premise in the Muskingum method of flood routing? Describe a procedure for estimating the values of Muskingum coefficient K and x for a stream reach. [P1/4(c) | 15M]
2023	✎ Discuss about the widely used in-situ water conservation practices for non-arable land with their suitability and limitation. [P1/2(a) | 10M] ✎ What do you understand by watershed prioritization? How can you prioritize the watershed for treatment from soil erosion and sediment yield point of view using remote sensing and GIS techniques? [P1/4(c) | 20M]
2022	✎ Describe guiding principles for watershed development projects as stipulated in the common guidelines. [P1/1(a) | 8M] ✎ What are sand dunes? Describe the procedure for fixing the sand dunes. [P1/1(b) | 8M] ✎ Explain how the following are determined in plane method of land levelling design: (i) Centroid of the field (ii) Slope of the plane of best fit (iii) Formation levels, cuts and fills. [P1/3(b) | 15M]
2021	✎ What are the different conservation measures to be followed for the treatment of watershed having maximum stream order III?. [P1/3(b) | 10M]
2020	✎ Discuss various methods of in-situ moisture conservation applicable for crop production under dryland areas. [P1/1(b) | 8M] ✎ Briefly describe various methods of reducing surface wind velocities in wind erosion control. [P1/2(a) | 10M] ✎ Describe importance of stream ordering in watershed study. [P1/3(a) | 10M]
2019	✎ Write about the methods used for computation of earthwork. Also, write in brief about different machineries/equipments used for land grading. [P1/4(a) | 10M]
2018	✎ What is integrated watershed management approach? Explain its different objectives. [P1/1(c) | 8M] ✎ Define hydrological drought. Write its components and their possible effects. List the measures that can be adopted to lessen the effects of drought in a region. [P1/1(d) | 8M] ✎ Define flood routing. Discuss the basic elements of flood routing. [P1/3(c) | 10M] ✎ What are the factors affecting land grading? How is survey carried out for land grading? Discuss commonly used methods for calculation of earth work. [P1/4(b) | 10M] ✎ What are the different types of soil movement due to wind erosion? Describe how the movements of the particles of various sizes take place in different types of movement. [P1/4(d) | 10M]
2017	✎ Discuss the issues and challenges related to watershed management. What is the role of peoples' participation in watershed development? [P1/1(a) | 8M] ✎ Discuss land shaping concepts, purpose and applicability in a watershed. [P1/1(b) | 8M] ✎ Explain in brief, different methods of calculating earth and soil volumes. [P1/1(c) | 8M] ✎ Explain the procedure to conduct a topographical survey of a watershed by direct contour method. [P1/1(d) | 8M]

	✎ Define Water Harvesting. Write the components and sequential steps for runoff water harvesting systems in the dry regions of India with suitable sketches. Also write the limitations of water harvesting systems. [P1/2(c) | 10M]
2016	✎ What are the main objectives of watershed management programme? What survey is required to be conducted while planning for watershed development? [P1/2(b) | 10M] ✎ Describe in brief the runoff inducing practices for increasing runoff for water harvesting. [P1/3(a) | 10M]

SECTION B – State PSC Previous-Year Questions

36 questions • All states · year-descending

✎ Describe the step-by-step procedure of the plane method of land levelling.

UK·PSC **ACF/RFO/Logging Officer (Mains) 2025** | **Agri. Engineering** | **Q.4(iii)** | 10M

✎ List and explain the methods of computing earthwork quantities in land grading.

UK·PSC **ACF/RFO/Logging Officer (Mains) 2025** | **Agri. Engineering** | **Q.4(iv)** | 10M

✎ | --- | --- | --- | --- | --- | | | BS | IS | FS | | | | | | A | 2.375 | | | | | 245.0 | BM | | B | | x | | 0.615 | | X | | | C | x | | 2.070 | | X | X | CP1 | | D | x | | 3.120 | | 0.190 | X | CP2 | | E | | 3.015 | | 0.450 | | X | | | F | | x | | 0.152 | | X | | | G | 2.665 | | 2.405 | x | | X | CP3 | | H | | x | | | 0.140 | X | | | I | | | x | 0.780 | | x | | - A trapezoidal irrigation canal of 10 m bottom width and side slopes 1.5 H : 1 V is to be constructed on a ground which is level in the transverse direction. The intended depths of the canal bed from the present ground surface at 40 m intervals are given below : 0.90 m, 1.25 m, 2.15 m, 2.50 m, 1.85 m, 1.35 m and 0.85 m Calculate the volume of earthwork required using trapezoidal formula and prismoidal formula.

OPSC·CSE **CSE (Main) 2024–25** | **Agri. Engineering** | **Paper-I, Q.2** | 15M

✎ Define farm pond and mention its purposes. Explain the process to calculate the capacity of a farm pond using contours. A hill slope having 15% slope is to be provided with bench terraces. The vertical interval of the terraces should be 1.5 m. Determine the length of the terrace and the earthwork per ha. What will be the area lost, if the batter slope given is 1 : 1?.

OPSC·CSE **CSE (Main) 2024–25** | **Agri. Engineering** | **Paper-I, Q.18** | 20M

✎ The bearings of the sides of a traverse ABCDE are as follows: | Side | Fore Bearing | Back Bearing | | --- | --- | --- | | AB | 107°15' | 287°15' | | BC | 22°0' | 202°O' | | CD | 281°30' | 101°30' | | DE | 189°15' | 9°15 | | EA | 124°45' | 304°45' | Compute the interior angles of the traverse. - What are the methods of earth work computation in land levelling design?.

OPSC·CSE **CSE (Main) 2023–24** | **Agri. Engineering** | **Paper-I, Q.3(a)** | 15M

✎ Explain various methods of land levelling design.

OPSC·CSE **CSE (Main) 2023–24** | **Agri. Engineering** | **Paper-I, Q.3(B)** | 15M

✎ Explain the components of the Universal Soil Loss Equation (USLE) in estimating soil loss. What are the limitations of using the USLE in watershed management?.

OPSC·CSE **CSE (Main) 2023–24** | **Agri. Engineering** | **Paper-I, Q.14(b)** | 20M

✎ Explain the concept of integrated watershed development.

OPSC·CSE **CSE (Main) 2023–24** | **Agri. Engineering** | **Paper-I, Q.16(a)** | 20M

- How do remote sensing and GIS contribute to watershed management? Discuss their role in enhancing decision-making for soil and water conservation.

  OPSC·CSE CSE (Main) 2023–24 | Agri. Engineering | Paper-I, Q.16(b) | 20M

- Consider a wind turbine with a 5 m diameter rotor. The speed of the rotor at 10 m/s wind velocity is 130 r/min and its power coefficient at this point is 0.35. Calculate the tip speed ratio and torque coefficient of the turbine. What will be the torque available at the rotor shaft? Assume the density of air to be 1.24 kg/m3.

  OPSC·CSE CSE (Main) 2023–24 | Agri. Engineering | Paper-II, Q.7(b) | 15M

- Explain how water harvesting helps in agricultural field. Elaborate 'the different methods of water harvesting with suitable sketch. Describe about the methods of in-situ water harvesting.

  OPSC·Forest Forest Service (Main) 2023–24 | Agri. Engineering | Paper-I, Q.1(a) | 20M

- Explain flood routing and their types. Write their inflow - outflow relationship.

  OPSC·Forest Forest Service (Main) 2023–24 | Agri. Engineering | Paper-I, Q.3(a) | 20M

- Explain the channel routing model (Muskingum Equation).

  OPSC·Forest Forest Service (Main) 2023–24 | Agri. Engineering | Paper-I, Q.3(b) | 20M

- | --- | --- | --- | --- | --- | --- | --- | | GL (m) | 117.50 | 116.25 | 115. 95 | 116.65 | 117.20 | 117.85 | 115.75 | It is proposed that the formation level RL 115.00 should be kept constant of starting from the chainage 'zero'. The formation width of the road is 8 m and the side slope 1: 1. The ground is level transverse to the center line. Compute the volume of earthwork. - Classify the open channel flow and write the relationship among Chezy's formula, Manning's formula and Darcy- Weisbach formula.

  OPSC·CSE CSE (Main) 2022–23 | Agri. Engineering | Paper-I, Q.5(a) | 5M

- Explain the roles of RS and GIS in watershed planning, development and evaluation.

  OPSC·CSE CSE (Main) 2022–23 | Agri. Engineering | Paper-I, Q.16(a) | 12M

- Volumetric efficiency - Tappet clearance - Hydrogenation - King-pin inclination - Harvesting index - Calculate the theoretical power generated by a wind rotor of 5m diameter with wind velocity of 8.5km.h-1. Assume air density 1.25kg.m-3.

  HP·PSC RFO (Mains) 2021 | Agri. Engineering | Q.6(a) | 10M

- Define a watershed and describe the watershed management approach.

  UK·PSC RFO (Mains) 2021 | Agri. Engineering | Q.1(iii) | 10M

- Rainfall intensity : 5 cm/hr - Maximum 30 minutes rainfall intensity of the storm : 0.5 cm/hr - Observed soil loss : 4.5 tonnes/ha - LS factor = 1 (Assume depth of rainfall to be 3 cm) - Explain the basic concept of watershed dęvelopment. What are objectives of watershed development?.

  OPSC·CSE CSE (Main) 2020–21 | Agri. Engineering | Paper-I, Q.7(a) | 12M

- What are different phases of planning of watershed management activities?.

  OPSC·CSE CSE (Main) 2020–21 | Agri. Engineering | Paper-I, Q.7(b) | 12M

- What do you understand by integrated watershed development? Explain in detail.

OPSC·CSE CSE (Main) 2020–21 | Agri. Engineering | Paper-I, Q.7(c) | 12M

- What are the important considerations of watershed management - Investigation, Planning and Implementation?.
  OPSC·Forest Forest Service (Main) 2019–20 | Agri. Engineering | Paper-I, Q.2(a) | 20M
- Equilibrium moisture content - Food dehydration - Solvent extraction - Blanching - Juice extraction - Explain the procedure of laser land levelling.
  OPSC·CSE CSE (Main) 2017–18 | Agri. Engineering | Paper-I, Q.1(a) | 15M
- Write and explain various steps of planning watershed management programme.
  OPSC·CSE CSE (Main) 2017–18 | Agri. Engineering | Paper-I, Q.6(d) | 15M
- How the water harvesting system be advantageously used by Indian farmers to alleviate drought and submergence?.
  OPSC·CSE CSE (Main) 2017–18 | Agri. Engineering | Paper-I, Q.7(b) | 15M
- Describe the role of remote sensing and GIS in watershed planning.
  OPSC·CSE CSE (Main) 2017–18 | Agri. Engineering | Paper-I, Q.7(c) | 15M
- Discuss your views regarding gaps between planning and implementation of watershed development programme in the state of Odisha.
  OPSC·CSE CSE (Main) 2017–18 | Agri. Engineering | Paper-I, Q.7(d) | 15M
- Write an essay on the role of remote sensing and GIS in watershed planning.
  OPSC·CSE CSE (Main) 2016–17 | Agri. Engineering | Paper-I, Q.6(c) | 15M
- Describe, in brief, how small and marginal rainfed farmers become prosperous by adopting rainwater harvesting based integrated farming in your state.
  OPSC·CSE CSE (Main) 2016–17 | Agri. Engineering | Paper-I, Q.8(b) | 15M
- Explain the role of earth moving machines in land development works, particularly the use of laser land leveler in rice fields.
  OPSC·CSE CSE (Main) 2016–17 | Agri. Engineering | Paper-II, Q.4(c) | 15M
- Explain the different components of watershed management.
  OPSC·CSE CSE (Main) 2015–16 | Agri. Engineering | Paper-I, Q.7(c) | 20M
- Give a detailed note on the various water harvesting measures.
  OPSC·CSE CSE (Main) 2015–16 | Agri. Engineering | Paper-I, Q.8(a),(ii) | 10M
- What is watershed and why it is considered as a basic unit for agricultural development? What are the important steps to be considered for watershed planning?.
  OPSC·Forest Forest Service (Main) 2015–16 | Agri. Engineering | Paper-I, Q.2(b) | 10M
- Define the term 'water harvesting'. What are the various techniques of water harvesting?.
  AP·PSC RFO (Mains) 2012 | Agri. Engineering | Q.3(E) | 8M
- Explain the term watershed management. Describe it's investigation, implementation, selection of priority

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areas and also provide watershed work plan.

AP·PSC RFO (Mains) 2012 | Agri. Engineering | Q.6 | 40M

✎ What is a flood? Describe various flood control measures in a watershed.

UK·PSC RFO (Mains) 2012 | Agri. Engineering | Q.3(ii) | 10M

✎ What are different methods of land-grading system? Write the steps for land-grading design in a rectangular field using plane method.

UK·PSC RFO (Mains) 2012 | Agri. Engineering | Q.3(iii) | 10M

SECTION C – Year × Source Heatmap

Dark = high frequency · Light = low frequency

SOURCE \ YEAR	25	24	23	22	21	20	19	18	17	16	12	TOTAL
IFoS	2	4	2	3	1	3	1	5	5	2	·	28
OPSC·CSE	2	6	2	·	3	·	·	5	3	2	·	23
OPSC·Forest	·	3	·	·	·	1	·	·	·	1	·	5
MH·PSC	·	·	·	·	·	·	·	·	·	·	·	0
UK·PSC	2	·	·	·	1	·	·	·	·	·	2	5
HP·PSC	·	·	·	·	1	·	·	·	·	·	·	1
AP·PSC	·	·	·	·	·	·	·	·	·	·	2	2

HOT SUBTOPICS – Most-asked themes in Chapter 4

Frequency bars scaled to top topic (23 questions)

- Watershed Management & Prioritization — 23 Qs
- Land Grading & Development — 16 Qs
- Water Harvesting & Moisture Conservation — 10 Qs
- Flood Control & Flood Routing — 5 Qs
- Wind Erosion Process — 3 Qs
- Stream Ordering & Watershed Hydrology — 2 Qs
- Drought & Sand Dune Management — 1 Qs

CHAPTER

5

AERIAL PHOTOGRAPHY & REMOTE SENSING

EMR · Resolutions · DIP · Photointerpretation · Spectral signatures · RS applications

OFFICIAL SYLLABUS – Chapter 5 Scope

UPSC IFoS — Agricultural Engineering, Paper I, Section A — Topic 1: Soil and Water Conservation

- **Chapter 5 covers:** Aerial photography — photointerpretation, stereoscopy, vertical exaggeration. Remote-sensing classification by platform, energy source, EM spectrum and bands. Active vs passive RS; geostationary and polar sun-synchronous satellites; satellite orbital characteristics. EMR interaction with atmosphere and Earth's surface; atmospheric windows; absorption and scattering. Spectral reflectance curves for soil, water and vegetation. Spatial, spectral and temporal resolution. Digital image processing — restoration, geometric and radiometric correction, classification, principal component analysis, false-colour composites, ground-truthing. Applications: agriculture, forestry, water resources, land cover/use mapping, archaeology, forest cover mapping, crop-water-stress monitoring, DEMs.

Full Topic 1 syllabus (this Chapter 5 + sister chapters in Module 1): Scope of soil and water conservation. Mechanics and types of erosion, their causes. Rainfall, runoff and sedimentation; rainfall erosivity and soil erodibility. Biological and engineering control measures (vegetative barriers, contour bunds, contour trenches, contour stone walls, contour ditches, terraces, outlets, grassed waterways). Gully control structures — temporary and permanent — design of permanent soil conservation structures (chute, drop, drop-inlet spillways). Design of farm ponds and percolation ponds. Flood routing. Watershed management — investigation, planning and implementation. Water harvesting and moisture conservation. Land development — levelling, estimation of earth volumes and costing. Wind erosion process. Design factors of shelter-belts and wind breaks. Forest (Conservation) Act.

SECTION A – UPSC IFoS Previous-Year Questions	*28 questions • 2016 – 2025*
2025	✎ Discuss the classification of remote sensing based on platform, energy source, regions of electromagnetic spectrum and number of bands. [P1/4(a) | 15M] ✎ Discuss the importance and requirement of ground truthing in remote sensing. Explain the various parameters of ground truthing used for remote sensing of land cover types. [P1/4(b) | 15M] ✎ Write short notes on the following: (i) Remote sensing data products (ii) Digital elevation models (iii) Types of cameras for aerial photography (iv) Forest cover mapping using remote sensing (v) Application of remote sensing for crop water stress monitoring. [P1/4(c) | 10M]
2024	✎ Distinguish between absorption and scattering of remote sensing energy. [P1/1(e) | 8M] ✎ What are geometric correction and radiometric correction in digital image processing? [P1/3(c) | 15M]

	✎ Discuss the application of remote sensing in land cover and land use mapping. [P1/4(a) | 10M] ✎ What is the significance of principal component analysis in digital image processing? Also write down the advantages of digital image processing. [P1/4(b) | 15M]
2023	✎ Explain the process of 'restoration' and 'geometric correction' in digital image processing. [P1/1(d) | 8M] ✎ (i) What is false colour composite? (ii) Define atmospheric windows in relation to remote sensing. [P1/1(e) | 8M] ✎ What are the basic keys of image interpretation? Also enlist the sequences followed in the process of image interpretation. [P1/4(a) | 10M] ✎ How is classification done in digital image processing? [P1/4(b) | 10M]
2022	✎ (i) What do you understand by the word LANDSAT in image processing? (ii) What are the seasonal influences on images? [P1/1(d) | 8M] ✎ Remote sensing (image interpretation) has been used for archaeological investigations. Explain with example. [P1/1(e) | 8M] ✎ What are the factors that influence interpretation of the remote sensing images? Discuss different elements of air photo interpretation. [P1/4(a) | 20M] ✎ What are the differences between NASA satellite pictures and those of geostationary weather satellite? [P1/4(b) | 10M] ✎ For a stereo pair of figures, Vertical Exaggeration (VE) results because the perceived vertical scale is larger than the horizontal scale. Find the approximate amount of exaggeration for a case of stereo pair of figures in which air base is found to be 2000 m, height of the camera above terrain is 4000 m, apparent stereoscopic viewing distance is 50 cm, eye base for average adult is 7 cm. Interpret your findings. [P1/4(c) | 10M]
2021	✎ Discuss the ordering of each element of photointerpretation with respect to degree of complexity. [P1/1(e) | 8M] ✎ Describe the importance of spatial, spectral and temporal resolution. [P1/4(a) | 10M] ✎ Discuss the digital image processing sequence with the help of a flowchart. [P1/4(b) | 15M]
2020	✎ Differentiate between the following: (i) Geostationary satellite and Polar sun-synchronous satellite (ii) Active remote sensing and Passive remote sensing. [P1/1(d) | 8M] ✎ Define various satellite orbital characteristics. [P1/1(e) | 8M] ✎ Explain spectral reflectance curve with the help of neat sketch for soil, water and vegetation. [P1/4(a) | 15M] ✎ What are the methods of digital image processing? Discuss any one in detail. [P1/4(b) | 10M] ✎ Discuss the interaction of Electromagnetic Radiation (EMR) with the atmosphere and the Earth's surface. [P1/4(c) | 15M]
2019	✎ Explain briefly the application of remote sensing in water resources studies. [P1/1(c) | 8M] ✎ Explain the types of computer-assisted operations in digital image interpretation and analysis. [P1/2(c) | 10M]

2018	✎ Define remote sensing. What are the different stages in remote sensing data acquisition and processing? Diagram showing remote sensing system for resource management from source to end use may be given. [P1/1(e) | 8M]
2016	✎ Classify remote sensing based on type of data acquisition. Explain in brief the application of remote sensing in agriculture and forestry. [P1/4(a) | 10M]

SECTION B – State PSC Previous-Year Questions

19 questions • All states · year-descending

✎ What is remote sensing? Explain the significance of different types of resolutions associated with remote sensing data.

UK·PSC **ACF/RFO/Logging Officer (Mains) 2025 | Agri. Engineering | Q.4(i) | 10M**

✎ What is aerial photography? Explain the various elements of visual image interpretation used in analysing aerial photographs.

UK·PSC **ACF/RFO/Logging Officer (Mains) 2025 | Agri. Engineering | Q.4(ii) | 10M**

✎ 0.21 Slope - 0.2% Catchment area 2 ha. Runoff intensity 150 mm/h Runoff coefficient 0.60 Make rational assumptions if needed. - Discuss in details the basic elements of arial photography image interpretation.

MH·PSC **Forest Services (Mains) 2024 | Agri. Engineering | Q.2(b) | 15M**

✎ How do remote sensing and GIS contribute to watershed management? Discuss their role in enhancing decision-making for soil and water conservation.

OPSC·CSE **CSE (Main) 2023–24 | Agri. Engineering | Paper-I, Q.16(b) | 20M**

✎ Brief about the equipment for interpretation of photographic images and write the application of remote sensing techniques in agriculture.

OPSC·Forest **Forest Service (Main) 2023–24 | Agri. Engineering | Paper-I, Q.4(a) | 20M**

✎ What are the merits and demerits of conventional and remote sensing techniques. Explain the use of GIS in planning and development of watersheds, forest.

OPSC·Forest **Forest Service (Main) 2023–24 | Agri. Engineering | Paper-I, Q.4(b) | 20M**

✎ Explain the roles of RS and GIS in watershed planning, development and evaluation.

OPSC·CSE **CSE (Main) 2022–23 | Agri. Engineering | Paper-I, Q.16(a) | 12M**

✎ Spatial resolution and Temporal resolution - Ground observation platform and Airborne observation platform - Geosynchronous orbit and Sun synchronous orbit - Near-infrared and Middle-infrared region - Write short notes on:.

HP·PSC **RFO (Mains) 2021 | Agri. Engineering | Q.2(b) | 10M**

✎ Diffraction - Mie scattering - GIS - Irradiance - What are the essential components of remote sensing? Briefly explain about all the components of remote sensing?.

HP·PSC **RFO (Mains) 2021 | Agri. Engineering | Q.2(c) | 10M**

✎ What do you understand by land use and land cover mapping? How can you monitor land use and land cover changes by using remote sensing and GIS techniques?.

UK·PSC **RFO (Mains) 2021 | Agri. Engineering | Q.2(ii) | 10M**

✎ | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | | Ordinates Of DRH of 2.5 cm ER | 0 | 35 | 70 | 120 | 175 | 185 | 165 | 150 | 145 | 110 | 65 | 25 | 0 | - Role of remote sensing and GIS in watershed.

OPSC·CSE **CSE (Main) 2020–21 | Agri. Engineering | Paper-I, Q.5(d),(i) | 5M**

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- Compare the merits and demerits of conventional and remote sensing approaches.
  OPSC·Forest Forest Service (Main) 2019–20 | Agri. Engineering | Paper-I, Q.4(a) | 20M
- Describe the role of remote sensing and GIS in watershed planning.
  OPSC·CSE CSE (Main) 2017–18 | Agri. Engineering | Paper-I, Q.7(c) | 15M
- Write an essay on the role of remote sensing and GIS in watershed planning.
  OPSC·CSE CSE (Main) 2016–17 | Agri. Engineering | Paper-I, Q.6(c) | 15M
- Define resolution, topology, geodesy, sensor, atmospheric window, swath width and image parallax.
  OPSC·Forest Forest Service (Main) 2015–16 | Agri. Engineering | Paper-I, Q.2(d) | 10M
- Draw a neat graph of spectral reflectance curve for soil, water and vegetation using IRS bands and discuss them in short.
  OPSC·Forest Forest Service (Main) 2015–16 | Agri. Engineering | Paper-I, Q.4(c) | 10M
- Draw the spectral reflectance curves for vegetation soil and water and explain.
  UK·PSC RFO (Mains) 2015 | Agri. Engineering | Q.3(i) | 10M
- Differentiate between active and passive remote sensing. What are the stages of remote sensing?.
  UK·PSC RFO (Mains) 2015 | Agri. Engineering | Q.3(ii) | 10M
- What do you understand by remote sensing and satellite-imageries? Describe the processes involved in the interpretation of imageries for natural resources management in an area.
  UK·PSC RFO (Mains) 2012 | Agri. Engineering | Q.2(iii) | 10M

SECTION C – Year × Source Heatmap

Dark = high frequency · Light = low frequency

SOURCE \ YEAR	25	24	23	22	21	20	19	18	17	16	15	12	TOTAL
IFoS	3	4	4	5	3	5	2	1	·	1	·	·	28
OPSC·CSE	·	1	1	·	1	·	·	1	1	·	·	·	5
OPSC·Forest	·	2	·	·	·	1	·	·	·	2	·	·	5
MH·PSC	·	1	·	·	·	·	·	·	·	·	·	·	1
UK·PSC	2	·	·	·	1	·	·	·	·	·	2	1	6
HP·PSC	·	·	·	·	2	·	·	·	·	·	·	·	2
AP·PSC	·	·	·	·	·	·	·	·	·	·	·	·	0

HOT SUBTOPICS – Most-asked themes in Chapter 5

Frequency bars scaled to top topic (13 questions)

- Digital Image Processing — 13 Qs
- EMR & Atmospheric Interaction — 5 Qs
- Aerial Photography & Photointerpretation — 4 Qs
- RS Applications & Ground Truthing — 4 Qs
- Spectral Reflectance & Signatures — 3 Qs
- Satellites & Orbits — 3 Qs
- Resolution (Spatial / Spectral / Temporal) — 2 Qs

CHAPTER

6

GIS APPLICATIONS

GIS fundamentals · Data types · RS-GIS integration · Land/water/forest management

OFFICIAL SYLLABUS – Chapter 6 Scope

UPSC IFoS — Agricultural Engineering, Paper I, Section A — Topic 1: Soil and Water Conservation

- **Chapter 6 covers:** Geographic Information System (GIS) — principles, data types (raster and vector formats). Spatial analysis, attribute data and GIS software. Integration of remote sensing and GIS in land and water management, watershed development and prioritization, forest management, water resources, and other agricultural-engineering applications.

Full Topic 1 syllabus (this Chapter 6 + sister chapters in Module 1): Scope of soil and water conservation. Mechanics and types of erosion, their causes. Rainfall, runoff and sedimentation; rainfall erosivity and soil erodibility. Biological and engineering control measures (vegetative barriers, contour bunds, contour trenches, contour stone walls, contour ditches, terraces, outlets, grassed waterways). Gully control structures — temporary and permanent — design of permanent soil conservation structures (chute, drop, drop-inlet spillways). Design of farm ponds and percolation ponds. Flood routing. Watershed management — investigation, planning and implementation. Water harvesting and moisture conservation. Land development — levelling, estimation of earth volumes and costing. Wind erosion process. Design factors of shelter-belts and wind breaks. Forest (Conservation) Act.

SECTION A – UPSC IFoS Previous-Year Questions

6 questions • 2017 – 2025

2025	✎ Explain the application of GIS in the area of water resource development and management. [P1/1(e) | 8M]
2021	✎ (i) How does raster data format differ from vector data format in GIS? (ii) Differentiate between specular and diffusive reflectance. [P1/1(c) | 8M] ✎ Discuss about the GIS data types. [P1/1(d) | 8M] ✎ Discuss application of remote sensing and GIS in Forest Management. [P1/4(c) | 15M]
2018	✎ What is GIS? Name the applications of remote sensing and GIS in land and water management. Briefly discuss any three applications. [P1/2(a) | 10M]
2017	✎ Discuss the principles of GIS and remote sensing and their applications in watershed development and management. [P1/4(a) | 10M]

SECTION B – State PSC Previous-Year Questions

10 questions • All states · year-descending

✎ How do remote sensing and GIS contribute to watershed management? Discuss their role in enhancing decision-making for soil and water conservation.

OPSC·CSE **CSE (Main) 2023–24 | Agri. Engineering | Paper-I, Q.16(b) | 20M**

- What are the merits and demerits of conventional and remote sensing techniques. Explain the use of GIS in planning and development of watersheds, forest.
  OPSC·Forest Forest Service (Main) 2023–24 | Agri. Engineering | Paper-I, Q.4(b) | 20M
- Explain the roles of RS and GIS in watershed planning, development and evaluation.
  OPSC·CSE CSE (Main) 2022–23 | Agri. Engineering | Paper-I, Q.16(a) | 12M
- Diffraction - Mie scattering - GIS - Irradiance - What are the essential components of remote sensing? Briefly explain about all the components of remote sensing?.
  HP·PSC RFO (Mains) 2021 | Agri. Engineering | Q.2(c) | 10M
- What do you understand by land use and land cover mapping? How can you monitor land use and land cover changes by using remote sensing and GIS techniques?.
  UK·PSC RFO (Mains) 2021 | Agri. Engineering | Q.2(ii) | 10M
- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | | Ordinates Of DRH of 2.5 cm ER | 0 | 35 | 70 | 120 | 175 | 185 | 165 | 150 | 145 | 110 | 65 | 25 | 0 | - Role of remote sensing and GIS in watershed.
  OPSC·CSE CSE (Main) 2020–21 | Agri. Engineering | Paper-I, Q.5(d),(i) | 5M
- Describe the role of remote sensing and GIS in watershed planning.
  OPSC·CSE CSE (Main) 2017–18 | Agri. Engineering | Paper-I, Q.7(c) | 15M
- Write an essay on the role of remote sensing and GIS in watershed planning.
  OPSC·CSE CSE (Main) 2016–17 | Agri. Engineering | Paper-I, Q.6(c) | 15M
- What is GIS? What are the five components of GIS? Write utility of GIS in land and water resources management.
  OPSC·Forest Forest Service (Main) 2015–16 | Agri. Engineering | Paper-I, Q.4(d) | 10M
- Explain the Geographical Information System (GIS). Describe its role in planning and development of various resources in a watershed.
  UK·PSC RFO (Mains) 2012 | Agri. Engineering | Q.4(i) | 10M

SECTION C – Year × Source Heatmap

Dark = high frequency · Light = low frequency

SOURCE \ YEAR	25	24	23	21	18	17	16	12	TOTAL
IFoS	1	·	·	3	1	1	·	·	6
OPSC·CSE	·	1	1	1	1	1	·	·	5
OPSC·Forest	·	1	·	·	·	·	1	·	2
MH·PSC	·	·	·	·	·	·	·	·	0
UK·PSC	·	·	·	1	·	·	·	1	2
HP·PSC	·	·	·	1	·	·	·	·	1
AP·PSC	·	·	·	·	·	·	·	·	0

HOT SUBTOPICS – Most-asked themes in Chapter 6

Frequency bars scaled to top topic (16 questions)

- GIS Fundamentals & Principles — 16 Qs
- RS-GIS in Watershed Development — 5 Qs
- RS-GIS in Land & Water Management — 3 Qs
- GIS Data Types (Raster vs Vector) — 2 Qs
- RS-GIS in Forest Management — 1 Qs

CHAPTER

1

SOIL-WATER RELATIONS & IRRIGATION WATER REQUIREMENTS

Soil moisture · ET & crop water · Duty-Delta · Efficiencies · Scheduling · Conjunctive use

OFFICIAL SYLLABUS – Chapter 1 Scope

UPSC IFoS — Agricultural Engineering, Paper I, Section A — Topic 1: Soil and Water Conservation

- **Chapter 1 covers:** Soil-water-plant relationship — field capacity, permanent wilting point, available water, soil moisture coefficients, matric potential, soil moisture characteristic curve, Darcy's law of soil-water flow, infiltration. Methods of soil-moisture measurement (direct and indirect — gravimetric, tensiometer, pressure plate, neutron probe). Crop water requirement, irrigation water requirement, consumptive use, evapotranspiration (ETo, ETc, crop coefficient). Duty, delta and base period. Irrigation efficiencies — conveyance, application, storage, distribution, water-use, field water-use. Irrigation scheduling — when and how much to irrigate, management allowed deficit. Conjunctive use of surface and groundwater. Sources of irrigation in India and planning of minor irrigation projects. Warabandi system of water allocation.

Full Topic 1 syllabus (this Chapter 1 + sister chapters in Module 1): Soil-water-plant relationship. Water resources of India. Crop water requirements; consumptive use; quality of irrigation water. Measurement of soil moisture, irrigation water, infiltration; irrigation efficiencies. Methods of irrigation — surface, sub-surface, sprinkler and drip. Design of irrigation channels and canals; tanks, weirs, dams and spillways; underground pipeline distribution. Hydraulics of wells, well construction. Pumps — types, characteristics, selection, installation. Drainage of agricultural lands; design of subsurface and surface drainage systems; drainage of irrigated and salt-affected soils. Farm structures — site selection, design and construction of farm buildings, animal sheds, machinery and equipment shed, storage structures for food grains and feeds, hay and silage. Greenhouses; environmental control of animal shelters; farm fencing.

SECTION A – UPSC IFoS Previous-Year Questions	*34 questions • 2016 – 2025*
2025	✎ Discuss the important factors affecting planning and design of minor irrigation projects. [P1/5(a) | 8M] ✎ Discuss the critical differences between crop water requirement and irrigation water requirement. [P1/5(c) | 8M] ✎ Write short notes on the following : (i) Warabandi system of water allocation (ii) Conjunctive use of surface and groundwater (iii) Soil moisture characteristic curve (iv) Fertigation equipment (v) Reference evapotranspiration. [P1/6(c) | 10M]
2023	✎ Develop the relationship among delta, base period and duty of water. [P1/5(a) | 8M] ✎ Distinguish between reservoir storage efficiency and water storage efficiency. [P1/5(b) | 8M] ✎ An area of 25 hectares is to be irrigated by a pump working for 10 hours a day. The available

	moisture-holding capacity of the soil is 16 cm/m and the depth of root zone is 1 m. Irrigation is to be done when 50 percent of the available moisture in the root zone is depleted. The water application efficiency is 75 percent. The peak rate of moisture used by the crops is 5 mm/day (weighted average). The losses in water conveyance are negligible. Determine the irrigation period, net depth of water application, depth of water pumped per application, and the required capacity of irrigation system in hectare-cm/day and litres per second. [P1/6(a) | 20M]
2022	✎ Explain the different approaches for irrigation scheduling. [P1/6(a) | 15M] ✎ How is conjunctive use of surface and groundwater vital in the integrated water resource development?. [P1/6(b) | 15M] ✎ Distinguish between economic feasibility and financial feasibility of irrigation systems. [P1/7(c) | 10M] ✎ (i) Describe the water conveyance efficiency, water application efficiency, water storage efficiency and water distribution efficiency. [10 M] (ii) A one-hectare farm needs to be irrigated with a depth of 100 mm, if the percolation losses are 30%. What will be the amount of water required for irrigation? [5 M]. [P1/7(a) | 15M]
2021	✎ Discuss the working procedure and application of pressure plate apparatus for determining Soil Matric Potential and Water Content with the help of a neat sketch. [P1/6(a) | 15M] ✎ Enlist and discuss the principal methods for direct measurement of evapotranspiration. [P1/6(b) | 15M]
2020	✎ A tank has a water spread area of 40 hectares with an average depth of 3 m of water. Calculate the area of paddy crop of 120 days duration that can be irrigated if the duty is expressed as : (i) 960 hectare per m^3/sec (ii) 110 hectare cm and (iii) 90 hectare/million m^3 of water. [P1/6(a) | 15M] ✎ A stream of 130 litres/second was diverted from a canal and 100 litres/sec were delivered to the field. An area of 1·8 hectares was irrigated in 8 hours. The runoff loss in the field was 432 m^3. Available moisture holding capacity of the soil is 20 cm per meter depth of soil. Determine the water conveyance, water application and water storage efficiency. Irrigation was started at a moisture level of 50 percent of the available moisture. [P1/7(a·i) | 12M] ✎ Differentiate between the following : (i) Saline-alkali soil and Non-saline alkali soil (ii) Saturation capacity and Field capacity (iii) Permanent wilting point and Ultimate wilting point (iv) Soil texture and Soil structure. [P1/7(b) | 10M]
2019	✎ For a particular soil, moisture at field capacity is 29% (w/w) and irrigation is to be applied at a moisture content of 19% (w/w). The apparent specific gravity is 1·30 and depth of the soil to be wetted is 1 m. Determine - (i) hectare-cm of water per hectare of land; (ii) time required to irrigate 10 hectares of land with a 0·10 m^3/sec stream, if the efficiency of irrigation application is 75%. [P1/5(d) | 8M] ✎ Explain in detail the direct and indirect methods of soil moisture measurement/determination. [P1/6(a) | 10M] ✎ Explain irrigation efficiency and also explain its different types along with formulas to compute them. [P1/6(c) | 10M] ✎ The following data were obtained in determining the soil moisture content at successive depths in the root zone prior to applying irrigation water : The bulk density of the soil in the root zone was 1·50 gm/cc. The available moisture-holding capacity of the soil was 17·8 cm/m depth. Determine - (i) moisture content at different depths in the root zone; (ii) moisture content in the root zone at the time of irrigation; (iii) net depth of water to be applied to bring the moisture content to field

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	capacity; (iv) gross irrigation requirement at an estimated field irrigation efficiency of 70%. [P1/7(c) | 10M]
2018	✎ What are the different sources of irrigation in India? List different factors influencing planning and development of minor irrigation projects. What are the positive and negative impacts of irrigation on the ecosystem and environment?. [P1/5(a) | 8M] ✎ Discuss various factors influencing irrigation water requirement. How can you estimate total irrigation water requirement incorporating different components for a given field and crop?. [P1/5(c) | 8M] ✎ The soil moisture at Field Capacity (FC) is 25% (W/W) and the moisture content at the time of irrigating is 15% (W/W). The apparent specific gravity is 1·52 and depth of soil to be wetted is 90 cm. How much water in ha-cm per hectare must be applied?. [P1/5(d) | 8M] ✎ Explain the concept of conjunctive use of surface and groundwater in canal command areas for efficient water use. What are the advantages and limitations of conjunctive use?. [P1/6(a) | 10M] ✎ List different soil water coefficients. Explain the methodology to estimate maximum available soil water using these coefficients. [P1/7(a) | 10M] ✎ What is crop coefficient and how is it estimated using crop evapotranspiration and reference evapotranspiration? Explain briefly the factors influencing crop coefficient. [P1/7(c) | 10M] ✎ Irrigation scheduling involves determining "when to irrigate" and "how much to irrigate". Explain the factors to be considered in developing irrigation schedule, with an example. [P1/7(d) | 10M] ✎ What are the priorities given to environmental issues in irrigated commands? Considering a holistic view of irrigated agriculture and socio-economic constraints, explain the issues in brief. [P1/8(b) | 10M] ✎ In an exercise to develop design and operations plan for surface irrigation in wheat crop, an infiltration test was carried out. The following data were obtained from the test : Plot the infiltration rate vs time and find out basic infiltration rate. [P1/8(c) | 10M]
2017	✎ Differentiate between the following : (i) Water requirement and Irrigation requirement (ii) Crop water use efficiency and Field water use efficiency (iii) Evaporation and Consumptive use (iv) Confined and Unconfined aquifers. [P1/5(a) | 8M] ✎ Discuss the procedure to develop soil moisture characteristic curve and its critical points. [P1/5(b) | 8M] ✎ Discuss Darcy's law of soil water flow with a definition sketch. In what flow conditions is it applicable?. [P1/5(c) | 8M] ✎ A field soil sample prior to being disturbed has a volume of 82 cm^3. The sample weighed 125 grams. After drying at 105°C for 24 hours, the dry soil sample weighs 100 grams. What is the soil moisture content on weight basis and volume basis? What depth of water must be applied to the volumetric water content of the top 1 m of soil to 0·40? Assume the density of water as 1·00 gm/cm^3. [P1/5(e) | 8M]
2016	✎ Write short notes on the following irrigation efficiencies : (i) Water conveyance efficiency (ii) Water application efficiency (iii) Water storage efficiency (iv) Water distribution efficiency. [P1/5(b) | 10M] ✎ Tomato with 60 cm effective root zone depth is grown in a soil with field capacity and permanent wilting point of 22% and 8% respectively. Irrigation is applied after 40% depletion of the available moisture. Apparent specific gravity of soil = 1·6. Calculate the depth of irrigation required. If a

	pump delivers 10 l/s discharge, how much time will it take for the irrigation of 2 ha? Assume no loss of water. [P1/6(c) | 20M]

SECTION B – State PSC Previous-Year Questions

38 questions • All states · year-descending

- Define soil water potential. Discuss in detail the various components of soil water potential.

  UK·PSC **ACF/RFO/Logging Officer (Mains) 2025 | Agri. Engineering | Q.2(i) |** 15M

- A stream of 130 lit/s was directed from a canal and 100 litres per second were delivered to the field. An area of 1.5 ha was irrigated in 10 hours. The effective depth of root zone was 1.7 m. The runoff loss in the field was 450 m^3. The depth of water penetration varied linearly from 1.7 m at the head end of the field to 1.0 m at the tail end. Available moisture holding of the soil is 25 cm/m depth of soil. Determine the water conveyance efficiency, water application efficiency, water storage efficiency and water distribution efficiency. Irrigation was started at a moisture extraction level of 50% of the available moisture.

  UK·PSC **ACF/RFO/Logging Officer (Mains) 2025 | Agri. Engineering | Q.2(iii) |** 10M

- Explain moisture content and its measurement. Also give moisture content representation.

  UK·PSC **ACF/RFO/Logging Officer (Mains) 2025 | Agri. Engineering | Q.7(ii) |** 5M

- Define and describe field capacity and permanent wilting point. What do you understand by available water capacity and readily available water? Why are these important?.

  OPSC·CSE **CSE (Main) 2024–25 | Agri. Engineering | Paper-I, Q.3 |** 15M

- What are the different types of soil water?.

  OPSC·CSE **CSE (Main) 2023–24 | Agri. Engineering | Paper-I, Q.5(a) |** 15M

- What are the components of total soil water potential? Explain.

  OPSC·CSE **CSE (Main) 2023–24 | Agri. Engineering | Paper-I, Q.6(a) |** 15M

- What are the indirect methods of determination of soil moisture content?.

  OPSC·CSE **CSE (Main) 2023–24 | Agri. Engineering | Paper-I, Q.6(b) |** 15M

- Explain the terms evapotranspiration, potential evapotranspiration, reference crop ET and consumptive use.

  OPSC·CSE **CSE (Main) 2023–24 | Agri. Engineering | Paper-I, Q.7(a) |** 15M

- What are the methods of estimation of evapotranspiration?.

  OPSC·CSE **CSE (Main) 2023–24 | Agri. Engineering | Paper-I, Q.7(b) |** 15M

- What do you mean by irrigation scheduling? What are the various basis for scheduling irrigation?.

  OPSC·CSE **CSE (Main) 2023–24 | Agri. Engineering | Paper-I, Q.8(a) |** 15M

- Explain the evapotranspiration estimation methods based on climatological approach and in-situ measurement.

  OPSC·Forest **Forest Service (Main) 2023–24 | Agri. Engineering | Paper-I, Q.6(a) |** 20M

- Write about soil moisture content measuring techniques.

  OPSC·Forest **Forest Service (Main) 2023–24 | Agri. Engineering | Paper-I, Q.7(a) |** 20M

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- The following data were obtained in determining the soil moisture content at successive depths in the root zone prior to applying irrigation water:

  OPSC·Forest Forest Service (Main) 2023–24 | Agri. Engineering | Paper-I, Q.7(b) | 20M

- Field capacity - Wilting Point - Available water content - Maximum available soil moisture deficiency - Moisture equivalent - Write about the different soil moisture measuring methods.

  OPSC·CSE CSE (Main) 2022–23 | Agri. Engineering | Paper-I, Q.6(b) | 10M

- Define conjunctive use of water. What are the various benefits of conjunctive use of water?.

  UK·PSC RFO (Mains) 2021 | Agri. Engineering | Q.2(iv) | 10M

- A stream of 135 litres per second was diverted from a canal and 100 litres per second were delivered to the field. An area of 1.6 hectares was irrigated in eight hours. The effective depth of root zone was 1.8 m. The runoff loss in the field was 432 cu m. The depth of water penetration varied linearly from 1.8 m at the head end of the field to 1.2 m at the tail end. Available moisture holding capacity of the soil is 20 cm per metre depth of soil. Determine the water conveyance efficiency, water application efficiency, water storage efficiency and water distribution efficiency. Irrigation was started at a moisture extraction level of 50 per cent of the available moisture.

  OPSC·CSE CSE (Main) 2020–21 | Agri. Engineering | Paper-I, Q.1(c),(ii) | 12M

- Explain soil moisture constants with suitable figures.

  OPSC·CSE CSE (Main) 2020–21 | Agri. Engineering | Paper-I, Q.1(d),(i) | 8M

- Calculate the irrigation interval for a crop. of tomato with the help of the following data:.

  OPSC·CSE CSE (Main) 2020–21 | Agri. Engineering | Paper-I, Q.1(d),(ii) | 12M

- How can the field capacity moisture content of a soil be determined? Briefly explain the factors that influence it.

  OPSC·CSE CSE (Main) 2020–21 | Agri. Engineering | Paper-I, Q.2(a),(i) | 8M

- Find out the net quantity of irrigation water to be applied to a crop of potato with the following values of soil moisture content and other data:

  OPSC·CSE CSE (Main) 2020–21 | Agri. Engineering | Paper-I, Q.2(a),(ii) | 12M

- Find out the delta (duty) of potato if the crop has a base period of 90 days. Irrigation is applied at an average interval of 10 days and at each irrigation, 5 cm depth of water is applied.

  OPSC·CSE CSE (Main) 2020–21 | Agri. Engineering | Paper-I, Q.4(b),(ii) | 12M

- Describe different types of irrigation efficiency.

  AP·PSC RFO (Mains) 2018 | Agri. Engineering | Q.6(b) | 3M

- Define soil water. Describe the different forms of soil water.

  OPSC·CSE CSE (Main) 2018–19 | Agri. Engineering | Paper-I, Q.1(b),(i) | 8M

- A 2 ha area wheat crop is irrigated by an outlet of canal system with an outflow rate of 50 litres per second at the field head. Net depth of water application is 4.5cm. The consumptive use rate of the crop is 2.2mm per day. Assuming field efficiency 80 percent, determine the irrigation efficiency and irrigation period.

OPSC·CSE CSE (Main) 2018–19 | Agri. Engineering | Paper-I, Q.1(d),(ii) | 12M

- A farmer has 1 ha of land made into 5 borders of sizes 100m × 20m each. He applied water to this land when root zone depth is 95cm. After 48 hours of irrigation when soil achieved its field capacity, he takes a soil auger to the borders and by boring holes in to soil, he observed the wetted soil depts. at five different places were 75, 80, 97, 100 and 95 cm respectively. Determine the water distribution efficiency and storage efficiency.

  OPSC·CSE CSE (Main) 2018–19 | Agri. Engineering | Paper-I, Q.2(c),(ii) | 10M

- Explain various forms / types of irrigation efficiency including water use efficiency and relate it with water productivity.

  OPSC·CSE CSE (Main) 2017–18 | Agri. Engineering | Paper-I, Q.2(b) | 15M

- Explain the most popular method of estimating the evapotranspiration of crop and list out the others.

  OPSC·CSE CSE (Main) 2017–18 | Agri. Engineering | Paper-I, Q.3(a) | 15M

- Define field capacity, witting point, available soil moisture, consumptive use. How these terms are relevant in scheduling irrigation?.

  OPSC·CSE CSE (Main) 2017–18 | Agri. Engineering | Paper-I, Q.4(a) | 15M

- A farmer desires to raise the moisture content in a field from 16% to a field capacity at 24% by dry weight basis during irrigation. Each plot is divided into 0.2 ha border strips that is required to be irrigated in 40 minutes with an application efficiency of 75%. Determine:

  OPSC·CSE CSE (Main) 2016–17 | Agri. Engineering | Paper-I, Q.1(d) | 20M

- How do you determine the water requirement of crops? Discuss the various factors affecting it.

  OPSC·CSE CSE (Main) 2016–17 | Agri. Engineering | Paper-I, Q.3(d) | 15M

- Define the terms "Evapotranspiration". Write the different methods of estimation of Evapotranspiration and explain the working principle of lysimeter.

  OPSC·CSE CSE (Main) 2015–16 | Agri. Engineering | Paper-I, Q.8(b) | 10M

- Find the moisture content of a soil from the following data. Root zone depth = 2 m, moisture constant in the soil at the time of commencement of study =5%, dry density of soil = 1.5 g/cm3, water applied to the soil = 50 m3, water lost due to evaporation etc = 10% and area of plot = 1000 m2.

  OPSC·Forest Forest Service (Main) 2015–16 | Agri. Engineering | Paper-I, Q.5(b) | 20M

- What do you mean by irrigation scheduling? What are the different criteria for scheduling the irrigation for the field crops?

  OPSC·Forest Forest Service (Main) 2015–16 | Agri. Engineering | Paper-I, Q.5(c) | 20M

- What is meant by Duty and Delta of canal water? Drive the relationship between duty and delta for a given base period.

  OPSC·Forest Forest Service (Main) 2015–16 | Agri. Engineering | Paper-I, Q.7(a) | 10M

- What is the difference between 'Potential Evapotranspiration' and 'Reference Crop Evapotranspiration'?.

  AP·PSC RFO (Mains) 2012 | Agri. Engineering | Q.1(D) | 4M

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- What are the factors which affect the infiltration rate of water into soil?.
  AP·PSC RFO (Mains) 2012 | Agri. Engineering | Q.1(E) | 4M
- What are the different types of irrigation scheduling?.
  AP·PSC RFO (Mains) 2012 | Agri. Engineering | Q.2(E) | 5M
- How evapotranspiration is measured in field using lysimeter?.
  AP·PSC RFO (Mains) 2012 | Agri. Engineering | Q.3(B) | 8M

SECTION C – Year × Source Heatmap *Dark = high frequency · Light = low frequency*

SOURCE \ YEAR	25	24	23	22	21	20	19	18	17	16	12	TOTAL
IFoS	3	·	3	4	2	3	4	9	4	2	·	34
OPSC·CSE	1	6	1	·	6	·	3	3	2	1	·	23
OPSC·Forest	·	3	·	·	·	·	·	·	·	3	·	6
MH·PSC	·	·	·	·	·	·	·	·	·	·	·	0
UK·PSC	3	·	·	·	1	·	·	·	·	·	·	4
HP·PSC	·	·	·	·	·	·	·	·	·	·	·	0
AP·PSC	·	·	·	·	·	·	·	1	·	·	4	5

HOT SUBTOPICS – Most-asked themes in Chapter 1

Frequency bars scaled to top topic (35 questions)

- Soil-Water Relations & Soil Moisture — 35 Qs
- Crop Water Requirement & ET — 17 Qs
- Irrigation Efficiencies — 14 Qs
- Irrigation Scheduling & MAD — 7 Qs
- Duty, Delta & Base Period — 4 Qs
- Conjunctive Use & Warabandi — 4 Qs
- Sources of Irrigation & Planning — 2 Qs

CHAPTER

2

SURFACE, SPRINKLER & DRIP IRRIGATION METHODS

Border · Check basin · Furrow · Sprinkler types & design · Drip components & fertigation · Filtration

OFFICIAL SYLLABUS – Chapter 2 Scope

UPSC IFoS — Agricultural Engineering, Paper I, Section A — Topic 1: Soil and Water Conservation

- **Chapter 2 covers:** Surface irrigation methods — border (straight & contour), check basin, basin, furrow (level / graded / contour), wild flooding, corrugation. Hydraulic phases of surface irrigation (advance, ponding, depletion, recession) and infiltration opportunity time. Sprinkler irrigation — types based on portability (portable, semi-portable, solid-set, side-roll, centre-pivot, rain-gun), system components and layout, hydraulic design principles, design steps with formulas, uniformity measures, adaptability and limitations. Drip / micro-irrigation — types (surface drip, sub-surface drip, bubbler, micro-sprinkler), components (mainline, submain, lateral, emitter, dripper), design steps. Fertigation — methods of fertilizer injection and location of fertigation units. Filtration systems — sand-media, screen, hydrocyclone and disc filters.

Full Topic 1 syllabus (this Chapter 2 + sister chapters in Module 1): Soil-water-plant relationship. Water resources of India. Crop water requirements; consumptive use; quality of irrigation water. Measurement of soil moisture, irrigation water, infiltration; irrigation efficiencies. Methods of irrigation — surface, sub-surface, sprinkler and drip. Design of irrigation channels and canals; tanks, weirs, dams and spillways; underground pipeline distribution. Hydraulics of wells, well construction. Pumps — types, characteristics, selection, installation. Drainage of agricultural lands; design of subsurface and surface drainage systems; drainage of irrigated and salt-affected soils. Farm structures — site selection, design and construction of farm buildings, animal sheds, machinery and equipment shed, storage structures for food grains and feeds, hay and silage. Greenhouses; environmental control of animal shelters; farm fencing.

SECTION A – UPSC IFoS Previous-Year Questions	*18 questions • 2016 – 2025*
2025	✎ (i) Discuss the different types of drip irrigation systems based on installation method, emitter discharge rate and wetted soil surface area. [7 M] (ii) A sprinkler irrigation system is to be installed in an area of 20 hectares. The crop to be irrigated is wheat with gross application depth of 20 cm. The irrigation interval is 10 days with 12 operating hours per day. Determine the sprinkler irrigation system flow capacity in litres per second. [8 M]. [P1/6(b) | 15M]
2024	✎ Describe the main hydraulic principles involved in designing of sprinkler irrigation system. [P1/7(b) | 10M]
2023	✎ What are the limitations in the adoptability of check basin method?. [P1/5(c) | 8M]
2022	✎ Enlist the steps involved in design of drip irrigation system. [P1/5(a) | 8M]

2021	✎ Discuss the basic details of border method of irrigation with a neat sketch. [P1/5(a) | 8M] ✎ Discuss about adaptability and limitations of sprinkler irrigation. [P1/5(b) | 8M] ✎ Differentiate between Sand Media filter and Screen filter (used in drip / micro-irrigation systems). [P1/7(a·ii) | 5M] ✎ Estimate the time, in hours, required to give a 4 cm irrigation to a border strip 100 metres long and 6 metres wide with a discharge of 12 litres per second from a tube-well. Assume the water conveyance efficiency to be 72%. [P1/7(b) | 10M]
2020	✎ Discuss the important hydraulic phenomenon involved in border irrigation method. [P1/5(e) | 8M] ✎ Discuss the different types of sprinkler irrigation systems based on portability. [P1/6(c) | 15M]
2019	✎ What are the steps involved in the design of sprinkler irrigation system? Provide the formula, wherever required. [P1/8(b) | 10M] ✎ Explain different filtration systems used in drip irrigation. [P1/8(c) | 10M]
2018	✎ A field of wheat crop of size 200 × 100 m with water source located at the lower left corner in the field is to be irrigated using sprinkler irrigation system. The prevailing land slope is south to north. Draw a layout of sprinkler mainline and lateral lines with brief explanation. [P1/6(c) | 10M] ✎ What are the different methods for fertilizer injection (fertigation)? The location of fertigation systems is very important in drip irrigation systems. Discuss in brief. [P1/8(d) | 10M]
2017	✎ Draw a neat sketch showing the basic components of a drip irrigation system. Also describe the functions of each of them in brief. [P1/6(a) | 10M] ✎ Discuss sprinkler irrigation uniformity and its measures and describe the procedure to estimate it in the field. [P1/6(c) | 10M] ✎ Given : Climate Hot humid; Soil Fine sandy loam; Wind speed 7 km/h; Crop Wheat; Effective root zone depth 1·5 m; Water available in top soil (1·0 m) 167 mm/m; Water available in top soil (0·5 m) 183 mm/m; Irrigation application efficiency 80%; ECw 2·0 dS/m; ECe (for 10% yield reduction) 3·4 dS/m; Area 10 ha; Peak rate of water removal 7·6 mm/day; Management allowed deficit (MAD) 50%; Operating hours per day 12 hours. Find the Net and Gross depth of irrigation, Leaching requirement, Irrigation interval and Sprinkler system capacity. [P1/6(d) | 10M]
2016	✎ Discuss the major components of a drip irrigation system with necessary drawing. **[P1/6(b) | 10M]**

SECTION B – State PSC Previous-Year Questions

15 questions • All states · year-descending

✎ Discuss the advantages of sprinkler irrigation.

UK·PSC **ACF/RFO/Logging Officer (Mains) 2025 | Agri. Engineering | Q.1(ii) |** 10M

✎ Describe design parameters of border irrigation. What is the area commanded by a field setting a continuous supply of 0.60 m^3/s of water from a canal? Use following data:

MH·PSC **Forest Services (Mains) 2024 | Agri. Engineering | Q.2(c) |** 10M

✎ What do you mean by sprinkler irrigation? How does it differ from trickle irrigation? Differentiate between these two methods of irrigation. Work out the capacity of a sprinkler system to apply water at the rate of 1.5 cm/h. Two sprinkler lines 200 m long each with 18 sprinklers are spaced at 11 m intervals on each line. The sprinkler lines are spaced at 16 m intervals.

OPSC·CSE **CSE (Main) 2024–25 | Agri. Engineering | Paper-I, Q.12 |** 15M

✎ Describe the four phases of surface irrigation process with the help of a line diagram. Define and show the

infiltration opportunity time in the diagram. Why is infiltration opportunity time important? In an 80 m long and 5 m wise border, a stream of 8 lps was delivered from the upper end to irrigate a wheat crop. The stream was cut off as soon as it reached the lower end of the border in 70 min. Layer- wise soil moisture contents before irrigation and at field capacity are given below. Determine the application efficiency, if the root zone depth is 90 cm and apparent specific gravity of soil is 1.4.

OPSC·CSE **CSE (Main) 2024–25** | **Agri. Engineering** | **Paper-I, Q.15** | 20M

- Farmer has 1 hectare area with length and breadth of 100 m each in water scarcity region. He decided to have coconut plantation at a spacing of 7.5 m × 7.5m in his sandy loam filed. In the area the maximum pan evaporation during summer is 12 mm/day, pan coefficient is 0.7 and crop coefficient is 0.8. Design a drip irrigation system with assumption of any other necessary data.

  OPSC·Forest **Forest Service (Main) 2023–24** | **Agri. Engineering** | **Paper-I, Q.5(a)** | 20M

- Briefly describe about rain guns and what are the limitations for application of rain gun irrigation system?.

  HP·PSC **RFO (Mains) 2021** | **Agri. Engineering** | **Q.3(a)** | 10M

- Explain the working principles and components of drip irrigation system.

  OPSC·CSE **CSE (Main) 2020–21** | **Agri. Engineering** | **Paper-I, Q.3(a),(i)** | 8M

- Determine the required capacity of a sprinkler system to apply water at the rate of 1.25 cm/hr. Two 186 meters long sprinkler lines are required. Sixteen sprinklers are spaced at 12 metres intervals on each line. The spacing between lines is 18 m.

  OPSC·CSE **CSE (Main) 2020–21** | **Agri. Engineering** | **Paper-I, Q.3(a),(ii)** | 12M

- In general, pressurized irrigation s/stems are considered to be more efficient than surface irrigation systems. What are some factors that may decrease the irrigation efficiency of some sprinkler systems to below that of some surface irrigation systems?.

  AP·PSC **RFO (Mains) 2018** | **Agri. Engineering** | **Q.6(d)** | 6M

- Write the status and implementation of micro irrigation system in Odisha. What are the frequent field problems faced by farmers in this regard?.

  OPSC·CSE **CSE (Main) 2016–17** | **Agri. Engineering** | **Paper-I, Q.2(c)** | 15M

- Determine the required capacity of a sprinkler system to supply water at the rate of 1.25 cm/hr. Two 186 m long sprinkler lines are installed. Sixteen sprinklers are spaced at 12 m intervals on each line. The spacing between lines is 18 m, allowing 1 hour for moving each 186 m sprinkler line. How many hours would be required to apply a 5 cm depth of irrigation to a square 16 ha field? depth of irrigation to a square 16 ha field? area assuming that systems work for 10 hours daily?.

  OPSC·Forest **Forest Service (Main) 2015–16** | **Agri. Engineering** | **Paper-I, Q.6(a)** | 10M

- Enlist the components of Sprinkler Irrigation System. Briefly discuss the advantages and limitation of use of sprinkler system.

  UK·PSC **RFO (Mains) 2015** | **Agri. Engineering** | **Q.4(i)** | 10M

- Describe in brief the hydraulics of Border irrigation.

  UK·PSC **RFO (Mains) 2015** | **Agri. Engineering** | **Q.4(ii)** | 10M

- How does sprinkler irrigation differ from trickle irrigation?.

  AP·PSC **RFO (Mains) 2012** | **Agri. Engineering** | **Q.1(J)** | 4M

- Explain the advantages and limitations of a drip irrigation system. Describe the design criteria for drip irrigation system and mention the precautions in layout of drip irrigation system.

  UK·PSC **RFO (Mains) 2012** | **Agri. Engineering** | **Q.3(i)** | 10M

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SECTION C – Year × Source Heatmap									*Dark = high frequency · Light = low frequency*				
SOURCE \ YEAR	25	24	23	22	21	20	19	18	17	16	15	12	TOTAL
IFoS	1	1	1	1	4	2	2	2	3	1	·	·	18
OPSC·CSE	2	·	·	·	2	·	·	·	1	·	·	·	5
OPSC·Forest	·	1	·	·	·	·	·	·	·	1	·	·	2
MH·PSC	·	1	·	·	·	·	·	·	·	·	·	·	1
UK·PSC	1	·	·	·	·	·	·	·	·	·	2	1	4
HP·PSC	·	·	·	·	1	·	·	·	·	·	·	·	1
AP·PSC	·	·	·	·	·	·	·	1	·	·	·	1	2

HOT SUBTOPICS – Most-asked themes in Chapter 2

Frequency bars scaled to top topic (16 questions)

- Sprinkler Irrigation — **16** *Qs*
- Drip / Micro-Irrigation — **13** *Qs*
- Surface Irrigation Methods — **6** *Qs*
- Surface Irrigation Hydraulics — **2** *Qs*
- Fertigation — **1** *Qs*
- Filtration in Micro-irrigation — **1** *Qs*

CHAPTER

3

WATER MEASUREMENT & CONVEYANCE

Weirs · Flumes · Orifices · Velocity-area & pipe-flow methods · Underground pipelines

OFFICIAL SYLLABUS – Chapter 3 Scope

UPSC IFoS — Agricultural Engineering, Paper I, Section A — Topic 1: Soil and Water Conservation

- **Chapter 3 covers:** Open-channel flow-measurement devices — weirs (rectangular, triangular / V-notch, Cipoletti, trapezoidal), sharp-crested vs broad-crested, end-contraction effects, submerged weirs. Critical-depth flumes — Parshall flume and cut-throat flume, working principles and field installation. Orifice-type devices — free orifice, submerged orifice and orifice plate. Velocity-area methods — current meter, pitot tube, float method and the coordinate method for pipes discharging horizontally. Pipe-flow measurement — venturi meter, electromagnetic / magnetic flow meter, gated pipe. Underground pipeline distribution systems — layout, specialised structures (risers, stand-pipes, air vents, end plugs, surge / pressure-relief valves) and protection of pipelines from damage.

Full Topic 1 syllabus (this Chapter 3 + sister chapters in Module 1): Soil-water-plant relationship. Water resources of India. Crop water requirements; consumptive use; quality of irrigation water. Measurement of soil moisture, irrigation water, infiltration; irrigation efficiencies. Methods of irrigation — surface, sub-surface, sprinkler and drip. Design of irrigation channels and canals; tanks, weirs, dams and spillways; underground pipeline distribution. Hydraulics of wells, well construction. Pumps — types, characteristics, selection, installation. Drainage of agricultural lands; design of subsurface and surface drainage systems; drainage of irrigated and salt-affected soils. Farm structures — site selection, design and construction of farm buildings, animal sheds, machinery and equipment shed, storage structures for food grains and feeds, hay and silage. Greenhouses; environmental control of animal shelters; farm fencing.

SECTION A – UPSC IFoS Previous-Year Questions	*16 questions • 2016 – 2025*
2025	✎ List the different methods of water flow measurement on an agricultural farm for an underground/overground pipeline and for open channel network. Also, briefly discuss their principles of measurement. [P1/6(a) | 15M]
2024	✎ Enlist the structures to be used in measuring irrigation water and also write their suitability. [P1/5(a) | 8M]
2023	✎ How do air vents and end plugs protect the underground pipeline from damage?. [P1/7(a) | 10M]
2021	✎ Differentiate between Cipoletti weir and Rectangular weir. [P1/7(a·i) | 5M]
2020	✎ Discuss the specialised structures used with underground pipeline system to control the water and protect the pipeline from damage. [P1/5(a) | 8M] ✎ Discuss the coordinate method of measuring discharge from pipes discharging horizontally. [P1/5(b) | 8M]
2019	✎ Briefly explain various irrigation water measurement devices that can be installed in an irrigation

	channel. Use appropriate diagrams, wherever necessary. [P1/8(a) | 10M]
2018	✎ What is Parshall flume? Explain the working procedure of Parshall flume. How is it different from cut-throat flume?. [P1/5(e) | 8M]
2016	✎ Define a weir. Draw the neat sketch of a rectangular weir placed in a channel and label it. [P1/5(a) | 10M] ✎ Write in brief on the following : (i) Venturi meter (ii) Parshall flume (iii) Cipolletti weir (iv) Tensiometer. [P1/6(a) | 10M]

SECTION B – State PSC Previous-Year Questions	*12 questions • All states · year-descending*
✎ Brief the different method of irrigation water measurement. Explain about the measuring devices and their suitability. OPSC·Forest **Forest Service (Main) 2023–24 | Agri. Engineering | Paper-I, Q.5(c) | 10M**	
✎ Explain about the underground pipeline system with components. OPSC·CSE **CSE (Main) 2022–23 | Agri. Engineering | Paper-I, Q.9(a) | 5M**	
✎ Accuracy - Precision - Drift - State the principle of flow measurement using a venturi tube. OPSC·CSE **CSE (Main) 2022–23 | Agri. Engineering | Paper-II, Q.11(b) | 5M**	
✎ Describe a weir. In order to ensure reliable results from a weir, what rules need to be followed during weir installation and operation?. UK·PSC **RFO (Mains) 2021 | Agri. Engineering | Q.3(i) | 10M**	
✎ Water flows over a rectanguatr weir 1 m wide at a depth of 150 mm and afterwards passes through a triangular right-angled weir. Taking Cd for the rectangular and triangular weir as 0.62 and 0.59 respectively, find the depth over the triangular weir. OPSC·CSE **CSE (Main) 2020–21 | Agri. Engineering | Paper-I, Q.2(c),(ii) | 12M**	
✎ Pitot tube and - Cut-throat flume. - Calculate the discharge over a triangular notch of angle 80° when the water head over the notch is 0.4O m. Assume standard value of coefficient of discharge. AP·PSC **RFO (Mains) 2018 | Agri. Engineering | Q.8(c) | 4M**	
✎ The rise of water is an inverted pitot tube fitted in a pipe of 10cm diameter showed 3.1m and 0.8m above the water surface. Determine the flow rate in the pipe. OPSC·CSE **CSE (Main) 2018–19 | Agri. Engineering | Paper-I, Q.4(a),(ii) | 12M**	
✎ Explain the working of hydrants used in underground pipeline irrigation system. OPSC·CSE **CSE (Main) 2018–19 | Agri. Engineering | Paper-I, Q.4(b),(i) | 8M**	
✎ Explain about structures and devices used for underground pipeline system and mention common troubles encountered in underground pipe lines. OPSC·CSE **CSE (Main) 2015–16 | Agri. Engineering | Paper-I, Q.2(a) | 30M**	
✎ Compute the discharge of a ractangular weir 40 cm long with a head of 10 cm under the following conditions:. OPSC·CSE **CSE (Main) 2015–16 | Agri. Engineering | Paper-I, Q.3(a) | 30M**	
✎ Describe the various components of underground pipeline system with the help of a neat diagram. UK·PSC **RFO (Mains) 2015 | Agri. Engineering | Q.2(iii) | 10M**	
✎ Give the mathematical expressions for measurement of water flow by orifice (submerged and free flow),	

trapezoidal weir, 90o V notch and rectangular weir with appropriate sketches.

AP·PSC RFO (Mains) 2012 | Agri. Engineering | Q.3(D) | 8M

SECTION C – Year × Source Heatmap

Dark = high frequency · Light = low frequency

SOURCE \ YEAR	25	24	23	21	20	19	18	16	15	12	TOTAL
IFoS	1	1	1	1	2	1	1	2	·	·	10
OPSC·CSE	·	·	2	1	·	2	·	2	·	·	7
OPSC·Forest	·	1	·	·	·	·	·	·	·	·	1
MH·PSC	·	·	·	·	·	·	·	·	·	·	0
UK·PSC	·	·	·	1	·	·	·	·	1	·	2
HP·PSC	·	·	·	·	·	·	·	·	·	·	0
AP·PSC	·	·	·	·	·	·	1	·	·	1	2

HOT SUBTOPICS – Most-asked themes in Chapter 3

Frequency bars scaled to top topic (7 questions)

- Weirs (Rect / Tri / Cipoletti / Trapezoidal) — 7 Qs
- Underground Pipeline & Conveyance — 6 Qs
- Velocity-Area & Pipe Methods — 4 Qs
- Generic Water-Measurement Concepts — 4 Qs
- Critical-Depth Flumes (Parshall, Cut-Throat) — 3 Qs
- Orifices — 1 Qs

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CHAPTER

4

CANAL DESIGN, OPEN CHANNEL FLOW & FLUID MECHANICS

Canal network & lining · Manning–Chezy · Hydraulic jump · Reynolds–Froude · Bernoulli · Pipe flow

OFFICIAL SYLLABUS – Chapter 4 Scope

UPSC IFoS — Agricultural Engineering, Paper I, Section A — Topic 1: Soil and Water Conservation

- **Chapter 4 covers:** Canal design and construction — irrigation canals (main, branch, distributary, minor), canal cross-sections, canal network components, canal lining (rigid and flexible), regulators, escapes and falls. Open-channel flow — uniform vs non-uniform flow; Chezy and Manning equations; hydraulic radius and hydraulic mean depth; most-efficient (best-hydraulic) section; specific energy, critical flow and hydraulic jump; gradually varied flow surface profiles. Fluid mechanics fundamentals — fluid properties, pressure measurement and manometry, hydrostatic forces; Bernoulli's equation; Reynolds and Froude numbers; laminar vs turbulent flow; pipe-flow theory — Darcy–Weisbach equation, friction factor, major and minor losses; continuity equation.

Full Topic 1 syllabus (this Chapter 4 + sister chapters in Module 1): Soil-water-plant relationship. Water resources of India. Crop water requirements; consumptive use; quality of irrigation water. Measurement of soil moisture, irrigation water, infiltration; irrigation efficiencies. Methods of irrigation — surface, sub-surface, sprinkler and drip. Design of irrigation channels and canals; tanks, weirs, dams and spillways; underground pipeline distribution. Hydraulics of wells, well construction. Pumps — types, characteristics, selection, installation. Drainage of agricultural lands; design of subsurface and surface drainage systems; drainage of irrigated and salt-affected soils. Farm structures — site selection, design and construction of farm buildings, animal sheds, machinery and equipment shed, storage structures for food grains and feeds, hay and silage. Greenhouses; environmental control of animal shelters; farm fencing.

SECTION A – UPSC IFoS Previous-Year Questions	*3 questions • 2019 – 2024*
2024	✎ Compute most efficient width for an open ditch/channel with flow depth of 2·40 metres in silt loam soil. What are the velocity and channel capacity, if channel gradient is 0·09 per cent and Manning's roughness coefficient is 0·04? The side slope of the channel for silt loam soil can be taken as 1·5 : 1. [P1/6(a) | 15M]
2023	✎ Discuss in detail about the hydraulic design of open drains. [P1/6(c) | 10M]
2019	✎ Explain the components of canal network in a large irrigation project using diagram. [P1/5(a) | 8M]

SECTION B – State PSC Previous-Year Questions	*15 questions • All states · year-descending*
✎ What is the phenomena of hydraulic jump and explain the types of jumps in rectangular channels based on	

the values of Froude number?.

OPSC·CSE CSE (Main) 2023–24 | Agri. Engineering | Paper-I, Q.4(b) | 15M

- Compute the mean velocity and discharge for a depth of flow of 0.30 m from a lined trapezoidal channel of 0.6 m wide and side slope of 1.5 horizontal: 1 vertical. The Manning's roughness (n) is 0.012 and the bed slope is 00003.

  OPSC·CSE CSE (Main) 2023–24 | Agri. Engineering | Paper-I, Q.9(b) | 15M

- Design a parabolic-shaped grassed waterway to carry the peak flow of 6 m3/s on a 1% slope on erodible sandy soil. The waterway must have good grass cover and a permissible flow velocity of 1.5 m/s can be allowed. Assume the value of Manning's coefficient as 0-034.

  OPSC·CSE CSE (Main) 2023–24 | Agri. Engineering | Paper-I, Q.15(b) | 20M

- Explain about the hydraulic jump and types of flows based on Froude number.

  OPSC·CSE CSE (Main) 2022–23 | Agri. Engineering | Paper-I, Q.5(b) | 10M

- Explain the steps involved in designing the trapezoidal open channel.

  OPSC·CSE CSE (Main) 2022–23 | Agri. Engineering | Paper-I, Q.7(b) | 10M

- What do you mean by lining of channel? Discuss about the types of canal lining used for channel.

  OPSC·CSE CSE (Main) 2022–23 | Agri. Engineering | Paper-I, Q.8(a) | 5M

- Calculate the most efficient bottom width for a trapezoidal shaped drainage channel to carry a flow 2.5 m deep in clay soil. Compute the velocity and discharge capacity of the channel if the channel gradient is 0.04%.

  UK·PSC RFO (Mains) 2021 | Agri. Engineering | Q.3(iii) | 10M

- Explain the classifications of open channel flow with suitable examples.

  OPSC·CSE CSE (Main) 2020–21 | Agri. Engineering | Paper-I, Q.1(c),(i) | 8M

- What do you mean by hydraulic jump? Write the applications of hydraulic jump.

  OPSC·CSE CSE (Main) 2020–21 | Agri. Engineering | Paper-I, Q.2(c),(i) | 8M

- Define spécific energy in a channel section With the concept of specific energy, derive the criterion of critical state condition of a channel section on zero slope and velocity distribution coefficient is 1.0. Also show that at critical state of flow, the spcific energy head in a rectangular channel laid on a level ground equal to 1.5 times the depth of flow. Assume velocity distribution coefficient is 1.0.

  OPSC·CSE CSE (Main) 2018–19 | Agri. Engineering | Paper-I, Q.2(a),(i) | 10M

- Define hydraulic jump. How it is applicable in irrigation works?.

  OPSC·CSE CSE (Main) 2018–19 | Agri. Engineering | Paper-I, Q.2(b),(i) | 8M

- Show that, the most economical trapezoidal channel section is obtained when half of top width is equal to one of the sloping side.

  OPSC·CSE CSE (Main) 2018–19 | Agri. Engineering | Paper-I, Q.3(b),(i) | 8M

- Steady and unsteady flow - Uniform and non-uniform flow - Laminar and turbulent flow - What is open channel flow? Explain various formulae / methods for its measurement.

  OPSC·CSE CSE (Main) 2017–18 | Agri. Engineering | Paper-I, Q.1(d) | 15M

- Compare the Chezy's, Manning's and Darcy- Weisbach formula for design of earthen irrigation channel and correlate the resistance coefficients used in these formulae.

  OPSC·CSE CSE (Main) 2016–17 | Agri. Engineering | Paper-I, Q.3(c) | 15M

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✎ What is a hydraulic jump? Explain different practical applications of the phenomenon of hydraulic jump.
OPSC·Forest Forest Service (Main) 2015–16 | Agri. Engineering | Paper-I, Q.1(b) | 20M

SECTION C – Year × Source Heatmap								*Dark = high frequency · Light = low frequency*
SOURCE \ YEAR	24	23	21	19	18	17	16	TOTAL
IFoS	1	1	·	1	·	·	·	3
OPSC·CSE	3	3	2	3	1	1	·	13
OPSC·Forest	·	·	·	·	·	·	1	1
MH·PSC	·	·	·	·	·	·	·	0
UK·PSC	·	·	1	·	·	·	·	1
HP·PSC	·	·	·	·	·	·	·	0
AP·PSC	·	·	·	·	·	·	·	0

HOT SUBTOPICS – Most-asked themes in Chapter 4

Frequency bars scaled to top topic (10 questions)

- Manning–Chezy & Channel Hydraulics — 10 Qs
- Hydraulic Jump & Specific Energy — 6 Qs
- Reynolds, Froude & Flow Regimes — 3 Qs
- Canal Design & Network — 2 Qs

CHAPTER

5

GROUNDWATER, WELLS & PUMPS

Aquifers · Well hydraulics · Pumping & recuperation tests · Centrifugal & submersible pumps · Cavitation

OFFICIAL SYLLABUS – Chapter 5 Scope

UPSC IFoS — Agricultural Engineering, Paper I, Section A — Topic 1: Soil and Water Conservation

- **Chapter 5 covers:** Groundwater hydrology — subsurface vertical distribution of water, vadose zone, water table, perched water, capillary fringe. Aquifer types — confined, unconfined, semi-confined / leaky, perched — and their characteristics: specific yield, specific retention, storage coefficient, transmissibility / transmissivity, hydraulic conductivity. Well hydraulics — steady-state and unsteady flow to wells; Theim and Theis equations; drawdown, cone of depression, radius of influence; pumping test and recuperation test for aquifer parameters; specific capacity of wells. Well construction — open / dug wells, tube wells, dug-cum-bore, cavity, driven, filter-point, borewells; well screens, well development; tube-well design parameters. Pumps — centrifugal, reciprocating, submersible, jet, axial-flow, air-lift; pump characteristics, efficiency, effects of speed and impeller diameter; cavitation and its prevention; pump selection and installation; horsepower (WHP / BHP) and energy-cost calculations.

Full Topic 1 syllabus (this Chapter 5 + sister chapters in Module 1): Soil-water-plant relationship. Water resources of India. Crop water requirements; consumptive use; quality of irrigation water. Measurement of soil moisture, irrigation water, infiltration; irrigation efficiencies. Methods of irrigation — surface, sub-surface, sprinkler and drip. Design of irrigation channels and canals; tanks, weirs, dams and spillways; underground pipeline distribution. Hydraulics of wells, well construction. Pumps — types, characteristics, selection, installation. Drainage of agricultural lands; design of subsurface and surface drainage systems; drainage of irrigated and salt-affected soils. Farm structures — site selection, design and construction of farm buildings, animal sheds, machinery and equipment shed, storage structures for food grains and feeds, hay and silage. Greenhouses; environmental control of animal shelters; farm fencing.

SECTION A – UPSC IFoS Previous-Year Questions	*22 questions • 2016 – 2025*
2025	✎ Discuss the subsurface vertical distribution of groundwater with an emphasis on different types of subsurface water. [P1/5(b) | 8M]
2024	✎ What are the characteristics of the aquifer that influence yield of wells? Explain in brief. [P1/5(b) | 8M] ✎ Discuss the effect of pump speed and impeller diameter on the performance of centrifugal pump. [P1/6(b) | 10M] ✎ A well penetrating aquifer which is underlain and overlain by impermeable layers was tested with a uniform discharge of 1000 litres/min. The steady state drawdowns measured in two observation wells which were at 1·0 m and 10·0 m radial distances from the centre of the pumped well were

	13·40 m and 4·20 m, respectively. Determine the hydraulic properties of the aquifer, if its saturated thickness is 10·0 m. [P1/7(a) | 15M]
2023	✎ What is cavitation? How does it affect the performance of pumping system?. [P1/6(b) | 10M] ✎ What are the parameters to be considered in designing of tube wells? Explain. [P1/7(b) | 10M]
2022	✎ Discuss the different types of aquifers. [P1/5(b) | 8M]
2021	✎ Discuss the effect of speed and impeller diameter on pump performance. [P1/6(c) | 10M]
2020	✎ Differentiate between the following : (I) Semi confined aquifer and Perched water table, (II) Transmissibility and Storage coefficient, (III) Piezometric surface and Pumping water level, (IV) Single acting pump and Double acting pump. [P1/7(a·ii) | 8M] ✎ Discuss the basic requirements for any well screen. [P1/7(c) | 10M]
2019	✎ ¶Write short notes on (with sketches/diagrams, wherever required) : (i) Cavity tube wells (ii) Dug-cum-bore wells (iii) Driven wells (iv) Filter points. [P1/5(b) | 8M] ✎ Write in brief about different types of centrifugal pumps based on various criteria. [P1/6(b) | 10M] ✎ A pump lifts 95000 litres of water per hour against a total head of 20 m. Compute the water hp. If the pump has an efficiency of 75%, what size of prime mover is required to operate the pump? If a direct drive electric motor having an efficiency of 85% is used to operate the pump, compute the cost of electrical energy in a month of 30 days. The pump is operated for 12 hours per day for 30 days. The cost of electrical energy is ₹ 5 per unit. [P1/8(d) | 10M]
2018	✎ Differentiate between the following : (i) Specific capacity of well and Specific yield of aquifer (ii) Open wells and Tubewells (iii) Pumping test and Recuperation test of a well (iv) Confined and Unconfined aquifers. [P1/5(b) | 8M] ✎ A tubewell is established in an artesian aquifer. Find its yield in litres per hour for a drawdown of 3 m when the diameter of the well is 20 cm and the thickness of the aquifer is 30 m. Assume the coefficient of permeability to be 35 m/day. If the diameter of the well is doubled, find the increase in the yield, the other conditions remaining the same. Assume the radius of influence as 300 m in both cases. [P1/7(b) | 10M]
2017	✎ What is Cavitation? How does it affect the performance of a pumping system? How is it prevented in a centrifugal pump?. [P1/5(d) | 8M] ✎ Discuss the important aquifer characteristics influencing yields of wells. [P1/6(b) | 10M] ✎ A 25 cm diameter well is pumped at a uniform rate of 50 l/s. The drawdown observed at 1 m and 100 m distances from the centre of the well are 8 m and 40 m respectively. Determine the hydraulic conductivity of the water bearing strata. Assume the thickness of the saturated part of the aquifer as 25 m. [P1/7(b) | 10M] ✎ Discuss the Pumping Test of wells. Explain the step-by-step procedure adopted for conducting pumping tests of wells. [P1/7(c) | 10M] ✎ What are submersible pumps? Explain the complete procedure to install a submersible pump in a borewell including initial preparations, installation and testing. [P1/7(d) | 10M]
2016	✎ Define a centrifugal pump. Discuss the probable reasons when the centrifugal pump may fail to operate. [P1/5(c) | 10M] ✎ An engine-driven centrifugal pump is to be installed in an open well. The yield of the well is sufficient to deliver 16000 litres of water per hour. The static water level is 15 m and the pumping

	water level is 18 m from ground level. Total losses due to friction in pipe and accessories may be assumed 15% of the total static head. If the pump efficiency is 55% and drive efficiency is 70%, calculate the BHP of the engine required to drive the pump. [P1/5(d) | 10M]

SECTION B – State PSC Previous-Year Questions	*37 questions • All states · year-descending*

- Discuss the various methods used for well development.
  UK·PSC **ACF/RFO/Logging Officer (Mains) 2025 | Agri. Engineering | Q.1(iv) | 10M**
- Describe in detail the various methods used for tube-well drilling. Discuss the suitability of each method with respect to soil and site conditions.
  UK·PSC **ACF/RFO/Logging Officer (Mains) 2025 | Agri. Engineering | Q.2(ii) | 15M**
- What is cavitation? How does it affect the performance of a pumping system?.
  OPSC·CSE **CSE (Main) 2023–24 | Agri. Engineering | Paper-I, Q.10(a) | 15M**
- Briefly explain the steps in designing a tube well.
  OPSC·CSE **CSE (Main) 2023–24 | Agri. Engineering | Paper-I, Q.13(b) | 20M**
- A pump lifts 93600 lph against a total head of 21 m. Compute the water horsepower. If the pump has an efficiency of 72%, what size of prime mover is required to operate the pump? If a directly driven electric motor having efficiency of 80% is used to operate the pump, compute the cost of electrical energy in a month of 30 days. The pump is operated for 12 hours daily for 30 days. The cost of electrical energy is, say, 75 paise per unit.
  OPSC·CSE **CSE (Main) 2022–23 | Agri. Engineering | Paper-I, Q.9(b) | 10M**
- What is aquifer? Write the types and properties of aquifer.
  OPSC·CSE **CSE (Main) 2022–23 | Agri. Engineering | Paper-I, Q.13(a) | 8M**
- Explain about groundwater investigation methods.
  OPSC·CSE **CSE (Main) 2022–23 | Agri. Engineering | Paper-I, Q.14(b) | 12M**
- What is well development? List various methods of well development and also briefly describe the compressed air method of well development.
  UK·PSC **RFO (Mains) 2021 | Agri. Engineering | Q.3(ii) | 10M**
- A 30 cm well fully penetrates a confined aquifer 30 m deep. After a long period of pumping, at a rate of 1200 lit/min, the draw down in the wells at 20 and 45 m from the pumping well are found to be 2.2 and 1.8 m respectively. Determine the transmissibility of the aquifer. What is the drawdown in the pumped well?.
  OPSC·CSE **CSE (Main) 2020–21 | Agri. Engineering | Paper-I, Q.5(a),(ii) | 12M**
- Specific yield and specific retention.
  OPSC·CSE **CSE (Main) 2020–21 | Agri. Engineering | Paper-I, Q.5(d),(v) | 5M**
- Explain surface method of ground water exploration with suitable sketch.
  OPSC·CSE **CSE (Main) 2020–21 | Agri. Engineering | Paper-I, Q.6(a),(i) | 8M**
- Explain the ground water recharge estimation methods.
  OPSC·CSE **CSE (Main) 2020–21 | Agri. Engineering | Paper-I, Q.7(e) | 12M**
- A 10 cm diameter well penetrates a 10 m thick confined aquifer. The steady state drawdown was found to be 2.5 and 0.05 m at distances of 10 m and 40 m respectively, from the centre of the well, when the well was operated with constant discharge rate of 125 liters per minute for 12 hours. Using Dupuit-Theim

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equation, calculate the transmissibility and hydraulic conductivity of the aquifer.

OPSC-Forest Forest Service (Main) 2019–20 | Agri. Engineering | Paper-I, Q.5(b) | 20M

- What is Priming? Give reasons for requirement of frequent priming in a centrifugal pump. What is well development? Discuss its objectives.

OPSC-Forest Forest Service (Main) 2019–20 | Agri. Engineering | Paper-I, Q.5(c) | 20M

- Discuss groundwater recharge and discharge components for a basin.

AP-PSC RFO (Mains) 2018 | Agri. Engineering | Q.7(b) | 6M

- What is the reason that aquifer pollution is much more difficult to correct than surface water pollution?.

AP-PSC RFO (Mains) 2018 | Agri. Engineering | Q.7(c) | 3M

- What are the primary pollutants from agriculture that have contributed to aquifer pollution?.

AP-PSC RFO (Mains) 2018 | Agri. Engineering | Q.7(d) | 3M

- A single acting reciprocating pump is lifting water at the rate of 2.5m3 per minute to a storage tank at a height of 20m from the sump. The pump has a bore of 30 cm and a stroke of 40cm. Find the slip, coefficient of discharge and horse power required to operate the pump if the diameter of suction pipe is 10cm and the pump runs at 80 rpm. Assume an overall efficiency of 80 percent.

OPSC-CSE CSE (Main) 2018–19 | Agri. Engineering | Paper-I, Q.1(b),(ii) | 12M

- A centrifugal pump lifts 1500 litres per mintute against a total head of 15metres. Compute the water horse power. What size prime mover is required to operate the pump if the pump has an efficiency of 75 percent? If a direct drive electric motor having an efficiency of 82 percent is used to operate the pump. Compute the cost of electrical energy in a year. The pump is operated 8 hours daily for 240 days in a year. The cost of electrical energy is Rs. 3.10 per unit.

OPSC-CSE CSE (Main) 2018–19 | Agri. Engineering | Paper-I, Q.4(b),(ii) | 12M

- Define "Transmissibility" and "Storage Coefficient" of an aquifer.

OPSC-CSE CSE (Main) 2018–19 | Agri. Engineering | Paper-I, Q.5(a),(i) | 5M

- In an alluvial basin of 100km2, 85Mm3 of groundwater was pumped in a year and the groundwater table dropped by about 5m during the year. Assuming no replenishment, estimate the specific yield of the aquifer. If the specific retention is 14%, what is the porosity of the soil?.

OPSC-CSE CSE (Main) 2018–19 | Agri. Engineering | Paper-I, Q.5(a),(ii) | 10M

- Calculate the discharge from a tube well of 30cm diameter penetrating fully into a confined aquifer of 30m thick and having a permeability of 40m/day. The drawdown in the well is 3 m and zero drawdown at 300m from the well. If the diameter of the well is doubled, find the percentage increase in the yield, the other conditions remaining the same.

OPSC-CSE CSE (Main) 2018–19 | Agri. Engineering | Paper-I, Q.6(c) | 20M

- What is artificial recharge? How it differs from ground water recharge? Explain with practical examples.

OPSC-CSE CSE (Main) 2017–18 | Agri. Engineering | Paper-I, Q.5(b) | 15M

- How you seal brackish and saline aquifer horizons? When sea water intrusion takes place in coastal areas? Explain with example.

OPSC-CSE CSE (Main) 2017–18 | Agri. Engineering | Paper-I, Q.5(c) | 15M

- Explain, in brief, the measures for basin-wide ground water development.

OPSC-CSE CSE (Main) 2017–18 | Agri. Engineering | Paper-I, Q.5(d) | 15M

- Define confined and unconfined aquifer, recharge well, perched water table, drainable porosity and

ground water exploration.

OPSC·CSE CSE (Main) 2016–17 | Agri. Engineering | Paper-I, Q.5(b) | 20M

- A well penetrating an aquifer, underlain and overlain by impermeable layers was tested with a uniform discharge of 1,000 liters/min. The steady state drawdowns measured in two observation wells (1 m and 10 m radial distances from the center of the pumped well) were 13.4 m and 4.2 m respectively. Determine the hydraulic conductivity and transmissibility of the aquifer, if its saturated thickness is 10 m.

  OPSC·CSE CSE (Main) 2016–17 | Agri. Engineering | Paper-I, Q.6(a) | 30M

- Explain how the flow nets can be used to determine groundwater flow. Also derive the equation for estimation of groundwater flow velocity.

  OPSC·CSE CSE (Main) 2016–17 | Agri. Engineering | Paper-I, Q.7(b) | 15M

- A 10 m diameter well penetrates an 8m thick water bearing strata underlain and overlain by permeable beds. The well was operated with a constant discharge rate of 100 litres / min for 12 hours. The steady drawdowns were found to be 3 and 0.05m distances 10m and 50m respectively from the centre of the well. Using Dupuit-Thiem equation, calculate the transmissibility and hydraulic conductivity of the aquifer.

  OPSC·CSE CSE (Main) 2015–16 | Agri. Engineering | Paper-I, Q.6(b) | 20M

- Write a detailed note on various types of well screen.

  OPSC·CSE CSE (Main) 2015–16 | Agri. Engineering | Paper-I, Q.7(a),(i) | 10M

- A tube well having a capacity of 4000 lps operates 20 hours each day during the irrigation season. How much area can it command if the irrigation interval is 20 days and depth of irrigation is 7 cm?.

  OPSC·Forest Forest Service (Main) 2015–16 | Agri. Engineering | Paper-I, Q.8(a) | 10M

- Groundwater is fast depleting in most of the arid and semi arid regions of our country, what are the factors responsible for it and what solution you would like to offer to combat this situation as an engineer?.

  OPSC·Forest Forest Service (Main) 2015–16 | Agri. Engineering | Paper-I, Q.8(d) | 10M

- Discharge obtained from the centrifugal pump operated by engine was 10 litres per second. The Suction water table was 15 m and the pumping water level was 18 m from the ground. The total loss due to friction in pipes and accessories may be assumed to be 15 percent of total suction head. What should be the horse power required for lifting the water, if the pump efficiency is 60 percent and drive efficiency is 80 percent? Calculate the BHP of the engine required to drive the pump.

  UK·PSC RFO (Mains) 2015 | Agri. Engineering | Q.2(ii) | 10M

- What are the steps involved in the design of tube well?.

  AP·PSC RFO (Mains) 2012 | Agri. Engineering | Q.1(F) | 4M

- With the help of neat diagram, explain the working of centrifugal pump.

  AP·PSC RFO (Mains) 2012 | Agri. Engineering | Q.3(A) | 8M

- Explain the working principle of different types of centrifugal pump set for irrigation purpose and discuss the functions of its various parts.

  UK·PSC RFO (Mains) 2012 | Agri. Engineering | Q.2(iv) | 10M

- Explain the characteristics of saturated underground formations such as aquifer (confined and un-confined), aquiclude and aquifuge. Also, explain the Darcy's law for well hydraulics.

  UK·PSC RFO (Mains) 2012 | Agri. Engineering | Q.3(iv) | 10M

SECTION C – Year × Source Heatmap	*Dark = high frequency · Light = low frequency*

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SOURCE \ YEAR	25	24	23	22	21	20	19	18	17	16	15	12	TOTAL
IFoS	1	3	2	1	1	2	3	2	5	2	·	·	22
OPSC·CSE	·	2	3	·	4	·	5	3	3	2	·	·	22
OPSC·Forest	·	·	·	·	·	2	·	·	·	2	·	·	4
MH·PSC	·	·	·	·	·	·	·	·	·	·	·	·	0
UK·PSC	2	·	·	·	1	·	·	·	·	·	1	2	6
HP·PSC	·	·	·	·	·	·	·	·	·	·	·	·	0
AP·PSC	·	·	·	·	·	·	·	3	·	·	·	2	5

HOT SUBTOPICS – Most-asked themes in Chapter 5

Frequency bars scaled to top topic (21 questions)

- Aquifer Types & Characteristics — **21** *Qs*
- Groundwater & Subsurface Water — **13** *Qs*
- Well Types & Construction — **13** *Qs*
- Pump Types — **11** *Qs*
- Well Hydraulics & Pumping Tests — **9** *Qs*
- Pump Performance & Cavitation — **8** *Qs*

CHAPTER

6

DRAINAGE ENGINEERING, SALINITY & SOIL RECLAMATION

Surface & subsurface drains · Tile spacing (Hooghoudt) · Mole · Interceptor · Salinity · ESP-SAR · Reclamation

OFFICIAL SYLLABUS – Chapter 6 Scope

UPSC IFoS — Agricultural Engineering, Paper I, Section A — Topic 1: Soil and Water Conservation

- **Chapter 6 covers:** Agricultural drainage — definition, objectives, sources and ill effects of drainage problems; importance of drainage networks in canal-command areas. Drainage hydrology — drainage coefficient, drainable porosity, pore-space / void-ratio relationships. Surface drainage — open drains, layout, advantages and limitations. Subsurface drainage — tile drains, mole drains, pipe drains, pipeless drains; design parameters; tile-drainage spacing using Hooghoudt's equation; supplemental structures for long-life tile drainage. Specialised drains — interceptor, relief, vertical and bio-drainage. Sanitary drainage and sewage handling on agricultural / homestead premises. Soil salinity and reclamation — characteristics of saline, sodic and saline-sodic soils; ESP and SAR — relationship and significance; principles of saline-soil management; reclamation measures for salt-affected soils; sea-water intrusion. Leaching requirement — concept, estimation and design implications. Waterlogging and salt accumulation — causes, effects and management.

Full Topic 1 syllabus (this Chapter 6 + sister chapters in Module 1): Soil-water-plant relationship. Water resources of India. Crop water requirements; consumptive use; quality of irrigation water. Measurement of soil moisture, irrigation water, infiltration; irrigation efficiencies. Methods of irrigation — surface, sub-surface, sprinkler and drip. Design of irrigation channels and canals; tanks, weirs, dams and spillways; underground pipeline distribution. Hydraulics of wells, well construction. Pumps — types, characteristics, selection, installation. Drainage of agricultural lands; design of subsurface and surface drainage systems; drainage of irrigated and salt-affected soils. Farm structures — site selection, design and construction of farm buildings, animal sheds, machinery and equipment shed, storage structures for food grains and feeds, hay and silage. Greenhouses; environmental control of animal shelters; farm fencing.

SECTION A – UPSC IFoS Previous-Year Questions	*20 questions • 2016 – 2025*
2025	✎ An agricultural area of 1 hectare needs to be drained of excess water. The soil contains 47% pore space and the soil moisture content after gravitational drainage is 39% (by volume). Find the void ratio, drainable porosity and drainable water volume from the area. The effective root zone depth of the area is 0·9 m. [P1/5(d) | 8M] ✎ Discuss the advantages and limitations of surface drain and subsurface drain. Explain and discuss the information required to design and for the installation of subsurface drainage systems. [P1/7(a) | 15M]

	✎ Discuss the characteristics of saline, sodic and saline-sodic soils. Explain the principles and approaches of saline soil management. [P1/7(b) | 15M]
2024	✎ How does waterlogging and salt accumulation affect the agricultural land adversely? Explain in brief. [P1/5(c) | 8M] ✎ What are the supplemental structures used in tile drainage system for their successful functioning and long life?. [P1/6(c) | 15M]
2023	✎ (i) Compute the velocity of flow of water to be drained and discharge capacity of 150 mm diameter corrugated plastic pipe flowing full if the slope is 0·4 percent. Manning's roughness coefficient is 0·016. (ii) How will you reclaim and manage the saline soils? Explain. [P1/7(c) | 10M]
2022	✎ In a tile drainage system, drains are to be installed at impervious layer at the depth of 2·0 m below the ground surface. The hydraulic conductivity of the soil is 1·8 m/day. The average rate of recharge is 0·2 cm/day. Calculate the required spacing of the drains if water table is to be kept at 1·0 m from the ground surface. [P1/5(c) | 8M] ✎ Discuss mole drainage. [P1/6(c) | 10M] ✎ Describe in brief the reclamation of salt affected soils. [P1/7(b) | 15M]
2021	✎ Differentiate between Interceptor drainage and Relief drainage. [P1/7(a·iii) | 5M] ✎ (i) Define leaching requirement. How is leaching requirement estimated for the design of subsurface drainage? [5 M] (ii) Estimate the leaching requirement when the EC of the saturation extract of the soil is 11 mmho/cm at 25 percent reduction in the yield of cotton. The EC of irrigation water is 1·4 mmho/cm. [10 M]. [P1/7(c) | 15M]
2020	✎ Discuss about the pipe drain and pipless drains (mole) used in subsurface drainage system. [P1/6(b) | 10M] ✎ What is sanitary drainage system? What are the different types of drainage systems? What is the difference between sewage and drainage? How can drainage systems be improved?. [P1/8(b) | 10M]
2019	✎ What are the causes of waterlogging and soil salinity in an irrigated agriculture/agricultural field?. [P1/5(c) | 8M]
2018	✎ What is the importance of drainage network in canal command and large irrigation projects? List all the information required for design and installation of subsurface drainage systems. [P1/6(b) | 10M]
2017	✎ Differentiate between ESP and SAR. Derive the relationship between these two indices. What are salt affected soils? Explain different reclamation measures to manage salt affected soils. [P1/7(a) | 10M] ✎ Discuss the purpose, benefits and types of subsurface drainage systems. Explain the design of pipe drainage systems used for large irrigation projects. [P1/8(c) | 10M]
2016	✎ Define agricultural drainage. What are the sources and ill effects of drainage?. [P1/7(a) | 10M] ✎ Runoff water from a watershed enters into a drainage area for 8 hours at the rate of 3 m^3/s. The total rainfall during 24-hour period is 12 cm and the total infiltration during the period is 4 cm. If the total drainage area is 200 ha and the crop can tolerate a ponding of 10 cm, calculate the drainage coefficient of the land. [P1/7(b) | 20M] ✎ Discuss the following in brief : (i) Mole drain (ii) Interceptor drain (iii) Bio-drainage (iv) Channel

	lining. [P1/7(c) | 10M]

SECTION B – State PSC Previous-Year Questions

38 questions • All states · year-descending

- Discuss causes of water logging in Indian scenario. Design the main open drain with bed slope of 0.1% for a catchment area of 6 sq. km.Using following data:.
  MH·PSC **Forest Services (Mains) 2024 | Agri. Engineering | Q.4(b)** | 15M

- What is the drainage coefficient? Discuss its usage. A command area of 2500 hectares is to be provided with surface drainage in a heavy clay soil region of coastal Odisha. The area grows crops during the kharif (June-October) season, when the maximum rainfall expected over a 24-hour period is 220 mm. The runoff coefficient for this saturated soil is 0.80. The crop can tolerate a maximum of 48 hours of water ponding on the surface. Determine the drainage coefficient in mm/day and the required capacity of the main drain, if it drains the entire 2500 ha command.
  OPSC·CSE **CSE (Main) 2024–25 | Agri. Engineering | Paper-I, Q.5** | 15M

- What are the assumptions of the Hooghoudt's equation for the spacing of drains? Subsurface drains are to be constructed for lowering the water table from 0-6 m to 1.2 m below the ground level in 10 days. Tile drains are to be placed 2.0 m below the ground surface. Impervious layer exists at 4.8 m below the ground level. The drainable porosity is 8% and hydraulic conductivity is 0.8 m/day. Determine the spacing between the drains using Hooghoudt's equation.
  OPSC·CSE **CSE (Main) 2024–25 | Agri. Engineering | Paper-I, Q.6** | 15M

- Runoff water from the watershed enters into a drainage area for 5 hours at the rate of 24 m3/s. The total rainfall during a 24-hour period is 10 cm and infiltration during the same period is 2 cm. If the total drainage area is 500 ha and the crop can tolerate a ponding of 14 cm, calculate the drainage coefficient of the land.
  OPSC·CSE **CSE (Main) 2023–24 | Agri. Engineering | Paper-I, Q.11(a)** | 15M

- What is surface drainage? Explain the steps in surface drainage design in elaborate way.
  OPSC·CSE **CSE (Main) 2023–24 | Agri. Engineering | Paper-I, Q.11(b)** | 15M

- What is bio drainage? How is it better than conventional drainage methods?.
  OPSC·CSE **CSE (Main) 2023–24 | Agri. Engineering | Paper-I, Q.12(a)** | 20M

- What is waterlogging? Explain the adverse effect of waterlogging.
  OPSC·CSE **CSE (Main) 2022–23 | Agri. Engineering | Paper-I, Q.10(a)** | 5M

- Explain the surface and subsurface drainage methods with suitable sketch.
  OPSC·CSE **CSE (Main) 2022–23 | Agri. Engineering | Paper-I, Q.10(b)** | 10M

- Drainage coefficient - Leaching requirement - Drainage porosity - Hooghoudt's equation - Transmissivity - Explain about the soil reclamation methods for different types of problem soils.
  OPSC·CSE **CSE (Main) 2022–23 | Agri. Engineering | Paper-I, Q.11(b)** | 10M

- Determine the size of a tile at the outlet of a 6-hectare drainage system, if the drainage coefficient is 1 cm and the tile grade is 0.3%. Assume rugosity coefficient for the tile drain materials as 0.011.
  OPSC·CSE **CSE (Main) 2022–23 | Agri. Engineering | Paper-I, Q.12(a)** | 5M

- A drainage ditch draining 10 ha of land flows at a design capacity for three days following a storm. If the system is designed using a drainage coefficient of 2 cm, how much water will be removed during this period?.

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OPSC·CSE CSE (Main) 2020–21 | Agri. Engineering | Paper-I, Q.3(b),(ii) | 12M

- Bedding - Parallel field drain - Parallel open ditch - Design a trapezoidal drainage canal to drain 550 hectares of land having a drainage coefficient of 2.5 cm. The soil is silt loam for which the permissible velocity is 0.6 m/s. The recommended side slope of the channel for silt Joam is 1.5 horizontal to 1 vertical. It is decided to maintain a depth of flow to be equal to 1.2 m and bottom width of channel to be 0.75 m. Slope of the channel bed is 0.1%. Mannings coefficient is 0.04. Find out whether velocity of flow when carrying the drainage discharge is below the permissible velocity?.
  OPSC·CSE CSE (Main) 2020–21 | Agri. Engineering | Paper-I, Q.3(c),(ii) | 12M
- What are the reasons for water logging? How is categorization of waterlogged land done?.
  OPSC·CSE CSE (Main) 2020–21 | Agri. Engineering | Paper-I, Q.4(b),(i) | 8M
- Discuss about concept of mole drainage system and also suitable soil conditions for making mole drains?.
  OPSC·CSE CSE (Main) 2020–21 | Agri. Engineering | Paper-I, Q.4(c),(ii) | 12M
- List out the various structures used in a subsurface drainage system and state their uses.
  OPSC·CSE CSE (Main) 2020–21 | Agri. Engineering | Paper-I, Q.6(b),(i) | 8M
- In a tile drainage system, tile drains of 0.2 m diameter are to be used, The depth for the drain is 2 m below the soil surface. An impermeable layer was found at a depth of 6 m below the soil surface. The hydraulic conductivity of the soil which is uniform is 1 m/day. The area is irrigated once in 15 days and it is estimated that the losses are 30 mm in 15 days so that the average discharge of the drainage system is 2 mm/ day. Calculate the required spacing of the drains if the water table is to be kept at 1.5 m from the ground level (Given from table: for d= 4 m and L = 80 m, the equivalent depth is 3.55 m).
  OPSC·Forest Forest Service (Main) 2019–20 | Agri. Engineering | Paper-I, Q.6(b) | 20M
- Explain the technology for reclamation of** **saline and alkali soils?.
  OPSC·Forest Forest Service (Main) 2019–20 | Agri. Engineering | Paper-I, Q.8(a) | 20M
- Give two reasons for installing subsurface drainage in a field and discuss its importance.
  AP·PSC RFO (Mains) 2018 | Agri. Engineering | Q.9(a) | 4M
- Discuss the positive and negative environmental aspects of subsurface drainage.
  AP·PSC RFO (Mains) 2018 | Agri. Engineering | Q.9(b) | 6M
- Explain the concept of Bio-drainage.
  OPSC·CSE CSE (Main) 2018–19 | Agri. Engineering | Paper-I, Q.1(c),(i) | 8M
- Compute the drainage coefficient for design of open ditch system as surface drainage means for draining 1500 ha watershed area with the following informations:.
  OPSC·CSE CSE (Main) 2018–19 | Agri. Engineering | Paper-I, Q.3(a),(ii) | 10M
- Explain the process of sea water intrusion with a neat sketch and give the equation connected to it. Also, discuss the methods for controlling sea water instrusion.
  OPSC·CSE CSE (Main) 2018–19 | Agri. Engineering | Paper-I, Q.8(c) | 10M
- What is the drainage coefficient? Explain its role / importance in designing drainage system of agricultural area.
  OPSC·CSE CSE (Main) 2017–18 | Agri. Engineering | Paper-I, Q.1(e) | 15M
- Explain bio-drainage and mole-drainage with examples.
  OPSC·CSE CSE (Main) 2017–18 | Agri. Engineering | Paper-I, Q.2(c) | 15M

- Explain, in detail, various factors considered in designing sub-surface drainage system.
  OPSC·CSE CSE (Main) 2017–18 | Agri. Engineering | Paper-I, Q.4(b) | 15M
- Design a trapezoidal open ditch to drain 500 ha of land, having a drainage coefficient of 3 cm/day. The soil is silt loam (side slope = 1.5 cm/day. The soil is silt loam (side slope = 1.5 - 0.5 m/s) and maximum permissible slope of the channel bed is 0.1%. Assuming of the channel bed is 0.1%. Assuming.
  OPSC·CSE CSE (Main) 2016–17 | Agri. Engineering | Paper-I, Q.1(c) | 20M
- Determine the size of the tile required at the end of a 500m long tile line. If the drainage coefficient is 1 cm, grade is 0.3% and the tile spacing is 50 m.
  OPSC·CSE CSE (Main) 2016–17 | Agri. Engineering | Paper-I, Q.4(a) | 15M
- Define Drainage Coefficient. A drainage canal discharges 0.2 m3/s and drains 250 ha. What is the drainage coefficient of this land?.
  OPSC·CSE CSE (Main) 2016–17 | Agri. Engineering | Paper-I, Q.4(b) | 15M
- Explain the hydrologic and hydraulic design of surface and sub-surface drainage system.
  OPSC·CSE CSE (Main) 2016–17 | Agri. Engineering | Paper-I, Q.4(c) | 15M
- Define vertical drainage, mole drain, bio- drainage and interceptor drain.
  OPSC·CSE CSE (Main) 2016–17 | Agri. Engineering | Paper-I, Q.4(d) | 15M
- What are the causes of water logging and advantages of drainage?.
  OPSC·CSE CSE (Main) 2015–16 | Agri. Engineering | Paper-I, Q.1(c) | 20M
- Write the name of different types of surface and sub-surface drainage method adopted in India. Differentiate between mole drain and bedding system.
  OPSC·Forest Forest Service (Main) 2015–16 | Agri. Engineering | Paper-I, Q.6(c) | 10M
- What is meant by saline and alkaline soils? How to deal with the salinity and alkalinity problem of soil?.
  OPSC·Forest Forest Service (Main) 2015–16 | Agri. Engineering | Paper-I, Q.7(b) | 10M
- Explain types of tile drainage system with the help of neat sketch.
  UK·PSC RFO (Mains) 2015 | Agri. Engineering | Q.4(iii) | 10M
- State various harmful effects of water logging on crops.
  AP·PSC RFO (Mains) 2012 | Agri. Engineering | Q.1(K) | 4M
- Define the term 'Agricultural Drainage'. Name and discuss different surface and sub-surface drainage system.
  AP·PSC RFO (Mains) 2012 | Agri. Engineering | Q.3(C) | 8M
- What is agricultural drainage? Explain various benefits of drainage. A drainage channel drains 500 hector land with a discharge of 0.40 cubic metre per second. Compute the drainage coefficient.
  UK·PSC RFO (Mains) 2012 | Agri. Engineering | Q.1(iii) | 10M
- Explain the causes and characteristics of formation of alkaline and saline soils. Describe various methods for reclamation of these problem soils.
  UK·PSC RFO (Mains) 2012 | Agri. Engineering | Q.1(iv) | 10M

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SECTION C – Year × Source Heatmap												*Dark = high frequency · Light = low frequency*	
SOURCE \ YEAR	25	24	23	22	21	20	19	18	17	16	15	12	TOTAL
IFoS	3	2	1	3	2	2	1	1	2	3	·	·	20
OPSC·CSE	2	3	4	·	5	·	3	3	5	1	·	·	26
OPSC·Forest	·	·	·	·	·	2	·	·	·	2	·	·	4
MH·PSC	·	1	·	·	·	·	·	·	·	·	·	·	1
UK·PSC	·	·	·	·	·	·	·	·	·	·	1	2	3
HP·PSC	·	·	·	·	·	·	·	·	·	·	·	·	0
AP·PSC	·	·	·	·	·	·	·	2	·	·	·	2	4

HOT SUBTOPICS – Most-asked themes in Chapter 6

Frequency bars scaled to top topic (28 questions)

- Drainage Concepts & Coefficient — **28** *Qs*
- Surface & Subsurface Drains — **28** *Qs*
- Waterlogging — **7** *Qs*
- Specialised Drains (Interceptor, Relief, Bio) — **6** *Qs*
- Salinity & Salt-Affected Soils — **6** *Qs*
- Soil Reclamation & Leaching — **6** *Qs*
- Sanitary Drainage & Sewage — **1** *Qs*

CHAPTER

7

SURVEYING & LEVELLING

Chain · Compass · Traverse · Levelling (BS/FS/IS) · Plane table · Tacheometry · Contouring · Theodolite

OFFICIAL SYLLABUS – Chapter 7 Scope

UPSC IFoS — Agricultural Engineering, Paper I, Section A — Topic 1: Soil and Water Conservation

- **Chapter 7 covers:** Surveying fundamentals — classification of surveys, principles, scales and plotting. Chain & compass surveying — chain methods, prismatic compass, whole-circle and reduced bearings, magnetic declination, local attraction. Traversing — open and closed traverses, closing error, Bowditch's rule. Levelling — differential, profile, fly and reciprocal levelling; dumpy / auto / tilting levels; back-sight, fore-sight, intermediate sight, benchmark and change-point conventions; reduced-level computation by rise-and-fall and height-of-collimation methods; curvature and refraction corrections. Plane-table surveying — radiation, intersection, traversing, resection; two-point and three-point problems. Tacheometric surveying — stadia, tangential and subtense-bar methods. Contouring — contour interval, characteristics, methods and uses in agricultural land development. Theodolite traversing — types, parts, temporary and permanent adjustments; horizontal and vertical angle measurement. Modern surveying — total stations, GPS / GNSS basics.

Full Topic 1 syllabus (this Chapter 7 + sister chapters in Module 1): Soil-water-plant relationship. Water resources of India. Crop water requirements; consumptive use; quality of irrigation water. Measurement of soil moisture, irrigation water, infiltration; irrigation efficiencies. Methods of irrigation — surface, sub-surface, sprinkler and drip. Design of irrigation channels and canals; tanks, weirs, dams and spillways; underground pipeline distribution. Hydraulics of wells, well construction. Pumps — types, characteristics, selection, installation. Drainage of agricultural lands; design of subsurface and surface drainage systems; drainage of irrigated and salt-affected soils. Farm structures — site selection, design and construction of farm buildings, animal sheds, machinery and equipment shed, storage structures for food grains and feeds, hay and silage. Greenhouses; environmental control of animal shelters; farm fencing.

SECTION B – State PSC Previous-Year Questions

21 questions • All states · year-descending

- Describe the step-by-step procedure of the plane method of land levelling.
  UK·PSC **ACF/RFO/Logging Officer (Mains) 2025** | **Agri. Engineering** | **Q.4(iii)** | 10M
- The following data shown as (X) in the Table below from a levelling job are illegible owing to the exposure of sudden rainfall. Find those missing data marked as X:.
  OPSC·CSE **CSE (Main) 2024–25** | **Agri. Engineering** | **Paper-I, Q.1** | 15M
- What are the methods of traversing to determine the directions of survey lines? Explain with sketches.
  OPSC·CSE **CSE (Main) 2023–24** | **Agri. Engineering** | **Paper-I, Q.1(b)** | 15M

- What are the operations involved in plane table surveying?.
  OPSC·CSE CSE (Main) 2023–24 | Agri. Engineering | Paper-I, Q.2(a) | 15M
- The bearings of the sides of a traverse ABCDE are as follows: | Side | Fore Bearing | Back Bearing | | --- | --- | --- | | AB | 107°15' | 287°15' | | BC | 22°0' | 202°O' | | CD | 281°30' | 101°30' | | DE | 189°15' | 9°15 | | EA | 124°45' | 304°45' | Compute the interior angles of the traverse. - What are the methods of earth work computation in land levelling design?.
  OPSC·CSE CSE (Main) 2023–24 | Agri. Engineering | Paper-I, Q.3(a) | 15M
- Explain various methods of land levelling design.
  OPSC·CSE CSE (Main) 2023–24 | Agri. Engineering | Paper-I, Q.3(B) | 15M
- Write the different methods of levelling with neat sketch.
  OPSC·CSE CSE (Main) 2022–23 | Agri. Engineering | Paper-I, Q.1(a) | 5M
- The following consecutive readings were taken with a dumpy level along a chain line at a common interval of 15 m. The first reading was at chainage of 165 m where the Reduced Level (RL) is 98.085. The instrument was shifted after the fourth and ninth readings. Find the RL of all the points by any one of the method and apply the usual checks. 3.150, 2-245, 1.125, 0.860, 3.125, 2-760, 1.835, 1-470, 1.965, 1.225, 2.390 and 3.035 m.
  OPSC·CSE CSE (Main) 2022–23 | Agri. Engineering | Paper-I, Q.1(b) | 10M
- Describe about the function and components of prismatic compass with neat sketch.
  OPSC·CSE CSE (Main) 2022–23 | Agri. Engineering | Paper-I, Q.2(a) | 5M
- The following are the observed bearings of the lines of a traverse ABCDEA with a compass in a place where local attraction was suspected and find the correct bearings of the lines.
  OPSC·CSE CSE (Main) 2022–23 | Agri. Engineering | Paper-I, Q.2(b) | 10M
- | --- | --- | | AB | 191°45' | 13°0' | | BC | 39°30' | 222°30' | | CD | 22°15' | 200°30' | | DE | 242°45' | 62°45' | | EA | 330°15' | 147°45' | - Write about the classification of chain surveying, brief about the accessories required for chain surveying.
  OPSC·CSE CSE (Main) 2022–23 | Agri. Engineering | Paper-I, Q.3(a) | 5M
- Explain the area calculation procedure by different methods using plain table surveying with neat sketch.
  OPSC·CSE CSE (Main) 2022–23 | Agri. Engineering | Paper-I, Q.3(b) | 10M
- Write about the temporary adjustment of dumpy level.
  OPSC·CSE CSE (Main) 2022–23 | Agri. Engineering | Paper-I, Q.4(a) | 5M
- Explain the various methods of levelling with neat sketch.
  OPSC·CSE CSE (Main) 2020–21 | Agri. Engineering | Paper-I, Q.1(b),(i) | 8M
- The following successive readings were taken with a dumpy level along a chain line at common intervals of 20 m. The first reading was taken on a chainage 140 m. The RL of the second change point was 107.215 m. The instrument was shifted after the third and seventh readings. Calculate the RLs, of all the points. 3.150, 2 245, 1.125, 3.860, 2.125, 0.760, 2.235, 0.470, 1.935, 3.225 and 3.890 m.
  OPSC·CSE CSE (Main) 2020–21 | Agri. Engineering | Paper-I, Q.1(b),(ii) | 12M
- Calculate the capacity of a farm pond and having the area enclosed by different contours as follows (Contour interval 1m):.
  OPSC·CSE CSE (Main) 2020–21 | Agri. Engineering | Paper-I, Q.5(b),(ii) | 12M

- Differeniate between Plane and Geodetic surveying.
  OPSC·CSE CSE (Main) 2018–19 | Agri. Engineering | Paper-I, Q.1(a),(i) | 8M
- The following observations refer to reciprocal level taken with one leveling instrument: P and Q are the two points of the two banks of a river. The staff readings on P and Q were observed to'be 1.82 m and 2.74m respectively when the instrument was placed near to the point P; 0.92m and 1.60m when the instrument placed near to the point Q. The true R. I. of point P is 126.38. Find the true difference in elevation between points P and Q and the true elevation of Q.
  OPSC·CSE CSE (Main) 2018–19 | Agri. Engineering | Paper-I, Q.1(a),(ii) | 12M
- The area within the contour line at the site of reservoir and the face of the dam are as follows:.
  OPSC·CSE CSE (Main) 2018–19 | Agri. Engineering | Paper-I, Q.3(b),(ii) | 12M
- Compare "Height of Instrument" method with "Rise and Fall" method.
  OPSC·CSE CSE (Main) 2016–17 | Agri. Engineering | Paper-I, Q.3(a) | 15M
- What is surveying? What are the principles of surveying? Give general classification of surveying?.
  OPSC·CSE CSE (Main) 2015–16 | Agri. Engineering | Paper-I, Q.1(a) | 20M

SECTION C – Year × Source Heatmap

Dark = high frequency · Light = low frequency

SOURCE \ YEAR	25	24	23	21	19	17	16	TOTAL
IFoS	·	·	·	·	·	·	·	0
OPSC·CSE	1	4	7	3	3	1	1	20
OPSC·Forest	·	·	·	·	·	·	·	0
MH·PSC	·	·	·	·	·	·	·	0
UK·PSC	1	·	·	·	·	·	·	1
HP·PSC	·	·	·	·	·	·	·	0
AP·PSC	·	·	·	·	·	·	·	0

HOT SUBTOPICS – Most-asked themes in Chapter 7

Frequency bars scaled to top topic (11 questions)

- Levelling — 11 Qs
- Surveying Fundamentals — 5 Qs
- Chain & Compass Surveying — 3 Qs
- Traversing — 3 Qs
- Contouring — 2 Qs
- Plane Table & Tacheometry — 1 Qs
- Theodolite & Modern Surveying — 1 Qs

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CHAPTER

8

FARMSTEAD, STORAGE STRUCTURES & BUILDING MATERIALS

Farmstead planning · Dairy & poultry housing · Grain storage & silos · Fencing · Bricks/Concrete/Timber · Foundations

OFFICIAL SYLLABUS – Chapter 8 Scope

UPSC IFoS — Agricultural Engineering, Paper I, Section A — Topic 1: Soil and Water Conservation

- **Chapter 8 covers:** Farmstead planning — site selection, layout, factors influencing arrangement, facilities for a good farm house; rural water-supply distribution; sewage and on-farm waste handling; septic tank function; farm roadway design. Animal shelters — dairy barns (stanchion / stall / loose-housing), cattle sheds, manger and stanchion details; brooder houses; deep-litter and other poultry housing systems; environmental control of animal shelters. Storage structures for grains and feeds — traditional vs improved bins, PUSA storage bin, deep vs shallow bins, bag vs bulk storage, hermetic storage, CAP storage; design considerations and control of storage losses and humidity. Silos and silage storage — classification, pit silos, metallic vs concrete silos, components; silo design (load on bottom, economical diameter / depth). Farm fencing — methods of construction and materials; barbed-wire / electric / woven-mesh fencing; fence-cost estimation. Building materials — cement, concrete (slump test), bricks, stone, tiles, timber (seasoning), Surkhi, lime, mortar, aggregate, RCC. Soil Mechanics & Foundations — bearing capacity, foundation types, soil shear strength, angle of internal friction, consolidation; structural design considerations for farm buildings.

Full Topic 1 syllabus (this Chapter 8 + sister chapters in Module 1): Soil-water-plant relationship. Water resources of India. Crop water requirements; consumptive use; quality of irrigation water. Measurement of soil moisture, irrigation water, infiltration; irrigation efficiencies. Methods of irrigation — surface, sub-surface, sprinkler and drip. Design of irrigation channels and canals; tanks, weirs, dams and spillways; underground pipeline distribution. Hydraulics of wells, well construction. Pumps — types, characteristics, selection, installation. Drainage of agricultural lands; design of subsurface and surface drainage systems; drainage of irrigated and salt-affected soils. Farm structures — site selection, design and construction of farm buildings, animal sheds, machinery and equipment shed, storage structures for food grains and feeds, hay and silage. Greenhouses; environmental control of animal shelters; farm fencing.

SECTION A – UPSC IFoS Previous-Year Questions	*30 questions • 2016 – 2025*
2025	✎ With a neat drawing, explain the stanchion barn for housing of dairy animals. Mention its specific advantages. [P1/5(e) | 8M] ✎ What are the requirements of good water supply distribution system for farmstead? Briefly discuss about the different water distribution systems commonly adopted in farmstead. [P1/7(c) |

	10M] ✎ What are the advantages of deep litter poultry housing? Draw a neat sketch to accommodate 1000 birds. Take floor area of 0·36 sq. m per bird. [P1/8(c) | 10M] ✎ Write short notes on the following : (i) Electric farm fencing (ii) PUSA storage bin (iii) Advantages of greenhouse cultivation (iv) Requirements of good storage structures (v) Classification of lime used in farm housing. [P1/8(a) | 15M]
2024	✎ What is hermetic storage? List the advantages of using hermetic storage structures. [P1/5(d) | 8M] ✎ Write in brief about : (i) Woven Mesh type of farm fence (ii) Seasoning of Timber. [P1/5(e) | 8M] ✎ Write short notes on the following : (i) Functions of Septic Tank (ii) Brooder Houses (iii) Surkhi (iv) Slump Test on Concrete (v) CAP Storage System. [P1/7(c) | 15M] ✎ Discuss the importance of location selection for establishment of a farmstead. What are the facilities to be kept in mind while designing a good farm house?. [P1/8(a) | 15M] ✎ What are the different components of silo storage system? Mention specific advantages of metallic silos over concrete silos. [P1/8(b) | 15M]
2023	✎ **Design a bag storage structure for storing 300 tonnes of wheat with a stack of 10 bags in length, 10 bags in width and 10 bags in height. Each bag is of 100 cm × 60 cm × 30 cm dimension having capacity of 100 kg. Take a clear distance between the walls and the end of the stack as 0·8 m and between the stacks as 2·0 m. Give the complete floor plan of the structure with dimension and draw layout.** [P1/5(d) | 8M] ✎ **Discuss various factors to be taken care in designing a storage structure for grains. What measures can be adopted to improve the performance of traditional storage structure?.** [P1/8(a) | 10M] ✎ **Discuss how you plan to construct a new dairy barn. Discuss various dairy barn equipments. Compare between stall barn and loose housing barn.** [P1/8(c) | 20M] ✎ **How are bricks (the common building material) prepared in India? Classify bricks and briefly discuss about each type of brick.** [P1/8(b) | 10M]
2022	✎ What would be the storage structure for grains?. [P1/5(d) | 8M] ✎ How can you take care of drainage and sewage management?. [P1/5(e) | 8M] ✎ Explain the causes by which losses of grain occur during storage. Discuss about humidity to be maintained in the storage system. How can you control the losses?. [P1/8(a) | 15M] ✎ In your view, how should the design and construction of farm roadways be done?. [P1/8(c) | 10M] ✎ Write short notes on the properties of the common building materials used in construction : (i) Timber (ii) Brick (iii) Stone (iv) Tiles (v) Concrete. [P1/8(b) | 15M]
2021	✎ Work out the economical diameter and depth of silo/siloes to store sufficient quantity of silage for a herd of 650 dairy cows having average weight of 400 kg each. Number of days for which silage has to be fed = 240 days; Weight of 1 cu·m of silo = 675 kg; Thickness of silage to be fed each day = 10 cm; Quantity of silage to be fed per 100 kg of body mass = 4 kg; Maximum diameter of silo permitted = 6 m; Allowable loss of handling = 10%. [P1/5(c) | 8M] ✎ Write in brief about different types of poultry housing systems. List out the important equipment being used in poultry system. [P1/5(d) | 8M] ✎ What are different types of farm fencing based on method of construction and material used? Briefly describe the principle used for electric fencing of farm. [P1/5(e) | 8M]

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	✎ Differentiate between Deep and Shallow bins. Give the merits and demerits of Bag and Bulk storage system. [P1/8(a) | 15M] ✎ Give a comparative analysis between Loose housing barn and Stall barn. [P1/8(c) | 10M]
2020	✎ Describe the importance and significance of selection of a suitable site for a nuclear power plant. [P1/5(c) | 8M] ✎ Discuss safe disposal of all human sewage and domestic wastes in farmstead planning, illustrating suitable layout. How is it different from homestead planning?. [P1/8(a) | 20M] ✎ What are the considerations to frame water supply system in rural areas? Illustrate with examples. [P1/8(c) | 10M]
2019	✎ A cylindrical silo of 2·5 m diameter and 20 m in height is filled with wheat. Calculate the load on the bottom only. The silo is made of steel with smooth walls. The characteristics of stored wheat are as follows : (i) The minimum bulk density = 720 kg/m³ (ii) The maximum bulk density = 830 kg/m³ (iii) The minimum angle of internal friction = 25° (iv) The maximum angle of internal friction = 30° (v) The minimum angle of friction on smooth sheeting = 18°. [P1/5(e) | 8M] ✎ Calculate the cost of fencing a square farm of 25 ha fenced by barbed wire using cement concrete posts. Take the following values : (i) Posts ₹335 per post of cement (ii) Corner posts ₹500 per post (iii) Cost of barbed wire is ₹1,000 per 100 m (iv) Cost of earthwork @ ₹50 per pit (v) Cost of cement concrete @ ₹100 per pit (vi) Labour charges for fixing wire are ₹3,000 (vii) Cost of gate is ₹15,000. Assume 1·80 m high angle iron posts spaced 3 m apart with 6 lines of barbed wires are used. [P1/6(d) | 10M]
2018	✎ It is very important for a farmstead to be properly arranged. List and explain in brief, the factors to be considered for best arrangement of farmstead. [P1/6(d) | 10M]
2017	✎ Discuss dairy barns, their types and their components. Draw a model layout of a dairy farm for a 20 cow/buffalo unit. [P1/8(b) | 10M] ✎ What is a Farmstead? What factors govern the location of the farmstead on the farm?. [P1/8(d) | 10M]
2016	✎ Classify silos. Describe constructional features and use of pit silos. [P1/8(b) | 12M] ✎ A rectangular farm of 10 ha (500 m × 200 m) is to be fenced by barbed wires with concrete poles. Estimate the cost of fencing with six rows of barbed wires. Assume suitable values for spacing of posts and appropriate prices for posts and wires. [P1/8(c) | 16M]

SECTION B – State PSC Previous-Year Questions	*37 questions • All states · year-descending*
✎ What is seasoning of timber? Explain the necessity of seasoning and describe the various methods used for seasoning of timber. UK·PSC **ACF/RFO/Logging Officer (Mains) 2025 | Agri. Engineering | Q.3(ii) | 15M**	
✎ Deep litter poultry house. MH·PSC **Forest Services (Mains) 2024 | Agri. Engineering | Q.1(g) | 8M**	
✎ Enumerate the advantages of bulk storage of grain compared to bag storage. What is meant by CAP storage? State its importance in grain handling in India. List the biotic and abiotic factors affecting stored grain in warehouses. OPSC·CSE **CSE (Main) 2024–25 | Agri. Engineering | Paper-II, Q.9 | 15M**	

- What are the points to be considered in identifying the location of a farmstead?.
  OPSC·CSE CSE (Main) 2023–24 | Agri. Engineering | Paper-I, Q.17(a) | 20M
- Calculate the cost fencing a square farm of 25 hectares fenced by barbed weir using cement concrete posts. Make necessary assumptions.
  OPSC·Forest Forest Service (Main) 2023–24 | Agri. Engineering | Paper-I, Q.8(b) | 20M
- Explain about the analysis of bearing capacity of soil.
  OPSC·CSE CSE (Main) 2022–23 | Agri. Engineering | Paper-I, Q.18(a) | 8M
- Explain the major effects of biotic and abiotic factors on stored grain in a silo.
  OPSC·CSE CSE (Main) 2022–23 | Agri. Engineering | Paper-II, Q.6(a) | 10M
- Name various types of dairy barns. Describe the general purpose of dairy barn.
  UK·PSC RFO (Mains) 2021 | Agri. Engineering | Q.4(i) | 10M
- List types of grain storage structures used in different states of India and briefly describe Murai type grain storage structure.
  UK·PSC RFO (Mains) 2021 | Agri. Engineering | Q.4(ii) | 10M
- What are the important properties of concrete and why it has attained the status of major building material? What procedure should be followed for obtaining the best results form concrete work?.
  UK·PSC RFO (Mains) 2021 | Agri. Engineering | Q.4(iv) | 10M
- What is silage? Which crops are considered suitable for making silage? Differentiate between pit and trench silos.
  UK·PSC RFO (Mains) 2021 | Agri. Engineering | Q.5(iv) | 10M
- Explain, in detail, about foundation in block cotton soil.
  OPSC·CSE CSE (Main) 2020–21 | Agri. Engineering | Paper-I, Q.8(a) | 12M
- Explain the fundamental requirements of a poultry house.
  OPSC·CSE CSE (Main) 2020–21 | Agri. Engineering | Paper-I, Q.8(b) | 12M
- A brick pier 600 mm × 600 mm is 4 m high. It has to carry an axial load of 520 kN. The allowable bearning capacity of the soil on which the pier is to rest is 250 kN/m2. The weight of brick masonary is 18.84 kN/m3. The angle of repose is 30° and the weight of earth is 16 kN/m3. Design the suitable foundation for the pier.
  OPSC·CSE CSE (Main) 2020–21 | Agri. Engineering | Paper-I, Q.8(c) | 12M
- What is slump test? Explain it with suitable figures.
  OPSC·CSE CSE (Main) 2020–21 | Agri. Engineering | Paper-I, Q.8(e) | 12M
- What are various types of food grain storage structures? Explain aluminum bin and R.C.C. bin with schematic diagram. List out the factors affecting the design of silo.
  OPSC·CSE CSE (Main) 2020–21 | Agri. Engineering | Paper-II, Q.6(a) | 20M
- What is farmstead? What factors govern the location of the farmstead on the farm? Design a farm house for the owner having a family of 4 members. Draw the floor plan and give reasons for the same.
  OPSC·Forest Forest Service (Main) 2019–20 | Agri. Engineering | Paper-I, Q.7(a) | 20M
- Design a stanchion barn for 50 cows. Draw the floor plan indicating various portions clearly. Make the list of building materials to be arranged for the construction.
  OPSC·Forest Forest Service (Main) 2019–20 | Agri. Engineering | Paper-I, Q.7(b) | 20M

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- State the factors that determine the depth and size of foundation in a farm building.
  AP·PSC RFO (Mains) 2018 | Agri. Engineering | Q.10(c) | 4M
- Mention the reasons of treating timber before roofing farm building.
  AP·PSC RFO (Mains) 2018 | Agri. Engineering | Q.10(d) | 3M
- Give the reasons for placing a polythene sheet on a foundation of farm buildings.
  AP·PSC RFO (Mains) 2018 | Agri. Engineering | Q.10(e) | 3M
- Describe the manufacture of ordinary Portland cement by wet process, Also, draw the flow diagram.
  OPSC·CSE CSE (Main) 2018–19 | Agri. Engineering | Paper-I, Q.8(b) | 20M
- Explain the procedures for designing a silo.
  OPSC·CSE CSE (Main) 2018–19 | Agri. Engineering | Paper-I, Q.8(d) | 10M
- What are the building materials used on farm for various uses? Elaborate the bearing capacity of soil, factor of safety etc.
  OPSC·CSE CSE (Main) 2017–18 | Agri. Engineering | Paper-I, Q.8(c) | 15M
- How do you design grain storage structure and storage structures for semi perishables?.
  OPSC·CSE CSE (Main) 2016–17 | Agri. Engineering | Paper-I, Q.5(d) | 20M
- A straight gravity masonry dam of trapezoidal section has a top width of 1.6 m, base width of 3.2 m and a height of 6.2 m. the water impounding height is 5.6 m. the coefficient of friction is 0.5, the bearing capacity of soil is 25,000 kg/m2. Test the structural stability of the dam.
  OPSC·CSE CSE (Main) 2016–17 | Agri. Engineering | Paper-I, Q.7(c) | 30M
- Design a stanchion barn for 50 cows. Draw the floor plan, indicating various portions. Also, list out various building materials required for the construction.
  OPSC·CSE CSE (Main) 2016–17 | Agri. Engineering | Paper-I, Q.8(c) | 10M
- Design a farm house for 4 member family. Draw the floor plan.
  OPSC·CSE CSE (Main) 2016–17 | Agri. Engineering | Paper-I, Q.8(d) | 10M
- Name the different types of masonry foundations and explain.
  OPSC·CSE CSE (Main) 2015–16 | Agri. Engineering | Paper-I, Q.6(c),(ii) | 10M
- Detail the prerequisites for designing a dairy farm.
  OPSC·CSE CSE (Main) 2015–16 | Agri. Engineering | Paper-I, Q.7(a),(ii) | 10M
- Work out the economical diameter and depth of a silo to store sufficient quantity of silage for a herd of 400 dairy cows having an average body weight of 450 kg each. The cows are fed silage for 200 days a year.
  OPSC·Forest Forest Service (Main) 2015–16 | Agri. Engineering | Paper-I, Q.6(d) | 10M
- What is a Farmstead? What factors govern the location of the farmstead on the farm?.
  OPSC·Forest Forest Service (Main) 2015–16 | Agri. Engineering | Paper-I, Q.8(c) | 10M
- Explain the advantages of deep litter poultry houses in comparison to cage houses.
  UK·PSC RFO (Mains) 2015 | Agri. Engineering | Q.3(iii) | 10M
- What is Farmstead? What factors govern the location of the farmstead on the farm?.
  UK·PSC RFO (Mains) 2015 | Agri. Engineering | Q.3(iv) | 10M
- What is slump test on concrete? What is its significance in building construction.

AP·PSC RFO (Mains) 2012 | Agri. Engineering | Q.2(D) | 5M

✎ Discuss the properties of concrete and curing process.

AP·PSC RFO (Mains) 2012 | Agri. Engineering | Q.4(A) | 10M

✎ What is litter type poultry house? What advantage it got over cage house?.

AP·PSC RFO (Mains) 2012 | Agri. Engineering | Q.4(B) | 10M

SECTION C – Year × Source Heatmap

Dark = high frequency · Light = low frequency

SOURCE \ YEAR	25	24	23	22	21	20	19	18	17	16	15	12	TOTAL
IFoS	4	5	4	5	5	3	2	1	2	2	·	·	33
OPSC·CSE	1	1	2	·	5	·	2	1	4	2	·	·	18
OPSC·Forest	·	1	·	·	·	2	·	·	·	2	·	·	5
MH·PSC	·	1	·	·	·	·	·	·	·	·	·	·	1
UK·PSC	1	·	·	·	4	·	·	·	·	·	2	·	7
HP·PSC	·	·	·	·	·	·	·	·	·	·	·	·	0
AP·PSC	·	·	·	·	·	·	·	3	·	·	·	3	6

HOT SUBTOPICS – Most-asked themes in Chapter 8

Frequency bars scaled to top topic (19 questions)

- Building Materials — 19 Qs
- Animal Shelters (Dairy / Cattle / Poultry) — 14 Qs
- Farmstead Planning — 13 Qs
- Grain & Feed Storage — 13 Qs
- Silos & Silage Storage — 8 Qs
- Soil Mechanics & Foundations — 8 Qs
- Farm Fencing — 3 Qs

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CHAPTER

9

PLANT ENVIRONMENT, GREENHOUSE & PROTECTED CULTIVATION

Greenhouse types · Polyhouse design · Fan-and-pad cooling · Covering materials · Hydroponics

OFFICIAL SYLLABUS – Chapter 9 Scope

UPSC IFoS — Agricultural Engineering, Paper I, Section A — Topic 1: Soil and Water Conservation

- **Chapter 9 covers:** Greenhouse fundamentals — definition, principle of the greenhouse effect, advantages of greenhouse cultivation; classification of greenhouses (by shape, utility and construction). Greenhouse design and selection — location, orientation, structural-design factors, environmental-control requirements. Greenhouse environmental control — methods of cooling and heating; fan-and-pad evaporative cooling system, ventilation, shade nets. Greenhouse covering / glazing materials — glass, polyethylene, polycarbonate, acrylic, fibreglass; properties and selection. Polyhouses — components, types (low-cost, medium-cost, high-tech), design factors and installation in Indian conditions. Net houses and shade-net structures. Soilless cultivation — hydroponics, aeroponics — concepts and overview. Plant environment / climate control — light, temperature, humidity and CO_2 enrichment in protected cultivation systems.

Full Topic 1 syllabus (this Chapter 9 + sister chapters in Module 1): Soil-water-plant relationship. Water resources of India. Crop water requirements; consumptive use; quality of irrigation water. Measurement of soil moisture, irrigation water, infiltration; irrigation efficiencies. Methods of irrigation — surface, sub-surface, sprinkler and drip. Design of irrigation channels and canals; tanks, weirs, dams and spillways; underground pipeline distribution. Hydraulics of wells, well construction. Pumps — types, characteristics, selection, installation. Drainage of agricultural lands; design of subsurface and surface drainage systems; drainage of irrigated and salt-affected soils. Farm structures — site selection, design and construction of farm buildings, animal sheds, machinery and equipment shed, storage structures for food grains and feeds, hay and silage. Greenhouses; environmental control of animal shelters; farm fencing.

SECTION A – UPSC IFoS Previous-Year Questions	*9 questions • 2016 – 2025*
2025	✎ (i) Write briefly about the various aspects of selection and design of greenhouse. [10 M] (ii) Briefly describe the different types of silos which can be used to store animal feed/forage. [5 M]. [P1/8(b) | 15M]
2024	✎ What is the necessity of controlling environment inside the greenhouse? Briefly mention different methods to control greenhouse environment. [P1/8(c) | 10M]
2023	✎ Classify various types of greenhouse and briefly discuss each of them. [P1/5(e) | 8M]
2021	✎ What are the classifications of greenhouses based on shape? List the different covering

	materials used for greenhouses. [P1/8(b) | 15M]
2020	✎ What do you mean by Greenhouse Effect? How does it affect the climate? How can you build a low cost greenhouse?. [P1/5(d) | 8M]
2019	✎ Give the details of different greenhouse construction materials and covering materials. [P1/7(b) | 10M]
2018	✎ What are the main components of Polyhouse? Discuss various factors influencing the design and installation of Polyhouses in India for surface covered cultivation. [P1/8(a) | 10M]
2017	✎ Discuss various types of poly houses (low to high cost) used for cultivation of high value crops. Explain the working principle of fan and pad evaporative cooling systems. [P1/8(a) | 10M]
2016	✎ What is polyhouse? Describe the working of fan and pad cooling system with a neat sketch. [P1/8(a) | 12M]

SECTION B – State PSC Previous-Year Questions

3 questions • All states · year-descending

✎ Describe briefly the principle of operation and applications of solar greenhouse dryer in agriculture. Enumerate the steps involved in designing a solar tunnel dryer for a coconut farmer producing copra.

OPSC·CSE **CSE (Main) 2024–25 | Agri. Engineering | Paper-II, Q.5 | 15M**

✎ Briefly describe different types of loads for design and construction of a greenhouse.

HP·PSC **RFO (Mains) 2021 | Agri. Engineering | Q.4(d) | 10M**

✎ What are the advantages of green house and poly house technologies? Explain the principles of green house. Also describe the procedure for selection of site for the green house.

UK·PSC **RFO (Mains) 2021 | Agri. Engineering | Q.4(iii) | 10M**

SECTION C – Year × Source Heatmap

Dark = high frequency · Light = low frequency

SOURCE \ YEAR	25	24	23	21	20	19	18	17	16	TOTAL
IFoS	1	1	1	1	1	1	1	1	1	9
OPSC·CSE	1	·	·	·	·	·	·	·	·	1
OPSC·Forest	·	·	·	·	·	·	·	·	·	0
MH·PSC	·	·	·	·	·	·	·	·	·	0
UK·PSC	·	·	·	1	·	·	·	·	·	1
HP·PSC	·	·	·	1	·	·	·	·	·	1
AP·PSC	·	·	·	·	·	·	·	·	·	0

HOT SUBTOPICS – Most-asked themes in Chapter 9

Frequency bars scaled to top topic (8 questions)

- Greenhouse Fundamentals & Classification — **8** *Qs*
- Polyhouse & Net House — **3** *Qs*
- Environmental Control (Cooling / Heating) — **2** *Qs*

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