**19CE31E4 – GROUNDWATER HYDROLOGY**

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| **Course Category**  | Professional Elective  | **Credits**  | 3 |
| **Course Type**  | Theory | **Lecture - Tutorial - Practical**  | 3 - 0- 0 |
| **Prerequisite**  | Fluid mechanics | **Sessional Evaluation**  | 40 |
| **Semester End Exam Evaluation**  | 60 |
| **Total Marks**  | 100 |

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| **Course Objectives** | 1. To understand occurrence of ground water in hydrological cycle and groundwater budgeting.
2. To analyze the hydraulic properties of the aquifer and its influence on occurrence and movement of ground water.
3. To study the yield of wells in different types of aquifers by applying various groundwater theories.
4. To understand the various subsurface water exploration methods.
5. To comprehend various artificial recharge methods and their significance, as well as saline water intrusion and its controlling methods.
6. To study the aquifer behavior by applying various methods of analog modeling and understand the groundwater management methods.
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| **Course Outcomes** | CO1 | Understand the nature of groundwater and its role in the water cycle. |
| CO2 | Apply the concept of Darcy’s law for estimating discharge and understand their characteristics and classifications. |
| CO3 | Demonstrate the technology of water wells and groundwater monitoring. |
| CO4 | Explain the technology of investigating the surface and subsurface water. |
| CO5 | Understand the importance of artificial recharge and employ the artificial ground water recharge techniques and identify the saline water intrusion locations. |
| CO6 | Determine the characteristics of the aquifers with the help of modeling techniques.  |
| **Course****Content** | **UNIT – I****INTRODUCTION:** Ground water utilization and historical background – Ground water in hydrologic cycle - Ground water budget and ground water level fluctuations and environmental influence – Literature – Data-Internet resources.**UNIT – II****OCCURRENCE AND MOVEMENT OF GROUND WATER**: Origin & age of ground water – Rock properties affecting groundwater – Groundwater column, zones of aeration & saturation, aquifers and their characteristics and classification –Groundwater basins & springs – Darcy’s Law – Permeability & its determination –Dupuit’s assumptions – Heterogeneity & anisotropy – Ground water flow rates & flow directions – General flow equations through porous media.**UNIT – III****ADVANCED WELL HYDRAULICS:** Steady and unsteady uniform radial flow to a well in a confined, unconfined and leaky aquifer – Well flow near aquifer boundaries for special conditions, partially penetrating, horizontal wells & multiple well systems – well completion – Development protection – Rehabilitation – Testing for yield.**UNIT – IV****SURFACE AND SUB-SURFACE INVESTIGATION OF WATER:** Geological – Geophysical Exploration – Remote Sensing – Electric Resistivity –Seismic refraction based methods for surface investigation of ground water – Test drilling & ground water level measurement – Sub-surface ground water investigation through geophysical – Resistivity – Spontaneous Potential – Radiation – Temperature – Caliper – Fluid Conductivity – Fluid Velocity – Miscellaneous Logging.**UNIT – V****ARTIFICIAL GROUND WATER RECHARGE:** Concept and methods of artificial ground water recharge – Recharge mounds and induced recharge – Waste water recharge for reuse – Water spreading.**SALINE WATER INTRUSION IN AQUIFERS:** Ghyben-Herzberg relation between fresh & saline waters – Shape & structure of the fresh and saline water interface – Upcoming of saline water – Fresh-saline water relations on oceanic islands – Seawater intrusion in karst terrains – Saline water intrusion control.**UNIT – VI****MODELING AND MANAGEMENT OF GROUND WATER:** Ground water modeling through porous media analog, electric analog and digital computer models – Ground water basin management concept – Hydrologic equilibrium equation. Ground water basin investigations – Data collection & field work – Dynamic equilibrium in natural aquifers – Management potential & safe yield of aquifers, stream– Aquifer interaction. |

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| **Textbooks****and****References** | **TEXTBOOKS:**1. David K. Todd, Larry W. Mays, *Groundwater hydrology*, Wiley India Pvt Ltd., 3rd edition, 2011.
2. H. M. Raghunath, *Ground Water*, New age publishers, 3rd edition, 2007.
3. R. N. Saxena and D.C. Gupta, *Elements of Hydrology and Groundwater*, PHI Learning, 3rd edition, 2017.

**REFERENCE BOOKS:**1. K. Subramanya, *Engineering Hydrology*, Tata McGraw Hill Publishing Company, 4th edition, 2019.
2. K. Karanth, *Ground Water Assessment, Development and Management*, McGraw Hill Education, 2nd edition, 2017.
3. Bhagu R. Chahar, *Groundwater Hydrology*, McGraw Hill Education, 1st edition, 2017.
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**CO-PO Mapping:** 3-High Mapping, 2-Moderate Mapping, 1-Low Mapping, - -Not Mapping

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|   | **PO1** | **PO2** | **PO3** | **PO4** | **PO5** | **PO6** | **PO7** | **PO8** | **PO9** | **PO10** | **PO11** | **PO12** |
| **CO 1** | 2 | - | - | - | 1 | - | 1 | - | - | - | - | 1 |
| **CO 2** | 3 | - | - | 1 | 1 | - | 1 | - | - | - | - | 1 |
| **CO 3** | 3 | 2 | - | - | 1 | - | 1 | - | - | - | 1 | 2 |
| **CO 4** | 2 | 2 | - | 1 | 1 | - | 1 | - | - | - | 1 | 1 |
| **CO 5** | 3 | - | - | 2 | 1 | - | 1 | - | - | - | 2 | - |
| **CO 6** | 2 | - | - | 1 | 1 | - | 1 | - | - | - | 1 | - |