**20CE31E2 – GROUNDWATER HYDROLOGY**

**(Civil Engineering)**

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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 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 uniformradial flow to a well in a confined, unconfinedand 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 – Wastewater 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, *Groundwater*, Newage 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, *Groundwater 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** | **PSO1** | **PSO2** | **PSO3** |
| **CO 1** | 2 | - | - | - | 1 | - | 1 | - | - | - | - | 1 | - | 1 | - |
| **CO 2** | 3 | - | - | 1 | 1 | - | 1 | - | - | - | - | 1 | 1 | 2 | 1 |
| **CO 3** | 3 | 2 | - | - | 1 | - | 1 | - | - | - | 1 | 2 | 1 | - | 1 |
| **CO 4** | 2 | 2 | - | 1 | 1 | - | 1 | - | - | - | 1 | 1 | - | 1 | - |
| **CO 5** | 3 | - | - | 2 | 1 | - | 1 | - | - | - | 2 | - | - | 2 | 2 |
| **CO 6** | 2 | - | - | 1 | 1 | - | 1 | - | - | - | 1 | - | 1 | 1 | 1 |