

| Course Code | Course Name                   | L-T-P-Credits | Year of Introduction |
|-------------|-------------------------------|---------------|----------------------|
| CE362       | GROUND IMPROVEMENT TECHNIQUES | 3-0-0-3       | 2016                 |

**Pre-requisite :CE305 Geotechnical Engineering - II**

**Course objectives:**

- To impart fundamental knowledge of Ground Improvement Techniques
- To make capable of choosing and designing the appropriate method of Ground Improvement according to site conditions and requirement

**Syllabus :**

Classification of Ground Modification Techniques- Soil distribution in India- Reclaimed soils- Ground Improvement Potential- Grouting – Aspects – Groutability, Grouting materials, Suspension grouts and solution grouts, Compaction grouting. Procedure and applications of grouting- Chemical stabilization – Granular admixtures, Cement, Lime, Calcium Chloride, Fly Ash, Bitumen, Chemical admixtures. Construction Methods-Ground Anchors – Applications, types and components, Anchor tests. Rock bolts – Applications and types- Rock bolt action around an excavation. Soil Nailing – construction sequence – analysis of nailed soil-Compaction- Moisture Density relationship. Shallow surface compaction-Rollers – operational aspects. Deep Compaction – Explosion- heavy tamping- vibro compaction and vibro replacement. Properties of compacted soil, Compaction control tests- Hydraulic modification- Methods of dewatering- open sumps and ditches, Well point systems, deep well drainage, Vacuum dewatering, Electro osmosis. Design of dewatering for excavations

**Expected Outcomes:**

- An understanding about types of ground improvement techniques and soil distribution in India
- Knowledge about various types of grouts and their applications
- Knowledge about types of chemical stabilization and their construction method
- Understanding about Ground Anchors, Rock Bolts and Soil Nailing
- Knowledge about Compaction of soil
- Understanding about various methods of dewatering of soil

**Text Books / References:**

1. Manfred. R. Hausmann, Engineering Principles of Ground Modification, McGraw Hill, 1989
2. P. Purushothamaraj, Ground Improvement Techniques ,University Science Press, 2005

**COURSE PLAN**

| Module | Contents                                                                                                                                                                      | Hours | Sem. Exam Marks % |
|--------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------|-------------------|
| I      | Introduction to Engineering Ground Modification- Classification of Ground Modification Techniques- Soil distribution in India- Reclaimed soils- Ground Improvement Potential. | 6     | 15                |

|                                    |                                                                                                                                                                                                                                                  |   |    |
|------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---|----|
| II                                 | Grouting – Aspects – Groutability, Grouting materials, Suspension grouts and solution grouts, Compaction grouting. Procedure and applications of grouting.                                                                                       | 6 | 15 |
| <b>FIRST INTERNAL EXAMINATION</b>  |                                                                                                                                                                                                                                                  |   |    |
| III                                | Chemical stabilization – Granular admixtures, Cement, Lime, Calcium Chloride, Fly Ash, Bitumen, Chemical admixtures. Construction Methods.                                                                                                       | 6 | 15 |
| IV                                 | Ground Anchors – Applications, types and components, Anchor tests. Rock bolts – Applications and types- Rock bolt action around an excavation. Soil Nailing – construction sequence – analysis of nailed soil                                    | 7 | 15 |
| <b>SECOND INTERNAL EXAMINATION</b> |                                                                                                                                                                                                                                                  |   |    |
| V                                  | Compaction- Moisture Density relationship. Shallow surface compaction-Rollers – operational aspects. Deep Compaction – Explosion- heavy tamping- vibro-compaction and vibro-replacement. Properties of compacted soil, Compaction control tests. | 9 | 20 |
| VI                                 | Hydraulic modification- Methods of dewatering- open sumps and ditches, Well point systems, deep well drainage, Vacuum dewatering, Electro osmosis. Design of dewatering for excavations.                                                         | 8 | 20 |
| <b>END SEMESTER EXAMINATION</b>    |                                                                                                                                                                                                                                                  |   |    |

**QUESTION PAPER PATTERN (End semester examination)**

**Maximum Marks :100**

**Exam Duration: 3 Hrs**

Part A -Module I & II : 2 questions out of 3 questions carrying 15 marks each

Part B - Module III & IV: 2 questions out of 3 questions carrying 15 marks each

Part C - Module V & VI : 2 questions out of 3 questions carrying 20 marks each

**Note :** 1.Each part should have at least one question from each module

2. Each question can have a maximum of 4 subdivisions (a,b,c,d)