

**RAJIV GANDHI PROUDYOGIKI VISHWAVIDYALAYA, BHOPAL**

**New Scheme Based On AICTE Flexible Curricula**

**Civil Engineering, VII-Semester**

**CE701- Geotechnical Engg**

**UNIT-I**

**INTRODUCTION, INDEX PROPERTIES AND CLASSIFICATION OF SOILS:** Definition and scope of soil mechanics, Origin of soil, formation of soil, clay minerals, Soil structure. 3-phase soil system, Basic terminology, and their relations, index properties of soil - Water content, Field density, Specific gravity, Grain size distribution by sieve and hydrometer analysis, Relative density, Atterberg limits and their determination, Various indices -Flow-Index, Plasticity Index, Toughness Index, Liquidity Index, Activity Ratio.

Different Systems of Soil Classification - Particle Size, Textural, Unified, HRB and IS classification. Field identification of soils

**UNIT –II**

**PERMEABILITY, EFFECTIVE STRESS AND SEEPAGE THROUGH SOILS :** Types of soil water, Capillarity in soils, Flow of water through soils, Darcy's Law, permeability, Factors affecting permeability, Laboratory & field tests for determination of coefficient of permeability, Permeability of layered soils.

Seepage pressure, total, Neutral and effective stress, Upward and downward seepage through soils, , Flow nets: characteristics, Methods of construction of flow net, Application of flow net, Quick condition, Laplace Equation for two –dimensional flow, Seepage through anisotropic soil and non-homogenous soil, Seepage through earth dam.

**UNIT-III**

**STRESS DISTRIBUTION IN SOILS AND COMPACTION:** Boussinesq's and Westergard's theories for point load, Uniformly loaded circular and rectangular areas, Pressure bulb, Variation of vertical stress under point load along vertical and horizontal plane, Newmark's influence chart for irregular areas. Contact pressure distribution in sands and clays.

Mechanism importance of compaction, Standard Proctor compaction test, Modified compaction test Factors affecting compaction, Effects of compaction on soil properties, Field compaction equipment and compaction quality control.

**UNIT-IV**

**CONSOLIDATION :**Types of compressibility, Spring analogy, Immediate settlement, Primary consolidation and secondary consolidation, Stress history of clay, e-p and e-log p curves, Normally consolidated soil, Over consolidated soil and under consolidated soil, Pre-consolidation pressure and its determination, Consolidation test, Terzaghi's 1-D consolidation theory, Coefficient of consolidation, Square root time and Logarithm of time fitting methods, Computation of total settlement.

## **UNIT-V**

### **SHEAR STRENGTH & STABILIZATION OF SOILS:**

**SHEAR STRENGTH:** Definition and importance of shear strength, Mohr and coulomb failure theories, Mohr's Stress Circles, Measurement of shear strength-Different types of Shear Test namely, Direct Shear Test, Unconfined Compression Test, Tri Axial Compression Test & Vane Shear Test for strength parameters, Strength tests based on drainage conditions, Measurement of pore pressure, Pore pressure parameters, Strength envelopes, shear strength of sands, Critical void ratio, Liquefaction, Shear strength of clays. Factors affecting shear strength of granular soils and cohesive soils.

**STABILIZATION OF SOIL:** Introduction, Mechanical stabilization, Cement stabilization, Lime stabilization, Bituminous stabilization, Chemical stabilization, Thermal stabilization, Electrical stabilization, Stabilization by grouting, Use of geo-synthetic materials, Types, Functions and applications of geo-synthetics, Reinforced earth structures-components and construction.

### **LIST OF EXPERIMENTS:**

1. Determination of water content by Oven drying method.
2. Determination of water content by Pycnometer
3. Determination of soil field density by core cutter method
4. Determination of soil field density by sand replacement method
5. Determination of Specific Gravity By Pycnometer.
6. Determination of Consistency Limits (i) Liquid Limit (ii) Plastic Limit (iii) Shrinkage Limit
7. Determination of liquid limit of soil by cone penetrometer.
8. Grain size analysis by sieve shaking method
9. Grain size analysis of fine grained soil by sedimentation using (i) pipette (ii) hydrometer.
10. Determination of coefficient of permeability of soil by- (a) constant head method (b) variable head method.
11. Determination of compaction parameters by- (a) light compaction, (b) heavy compaction.
12. Direct Shear test
13. Triaxial Test
14. Unconfined Compression Strength Test

### **Books and References**

1. Punamia B.C., Soil Mechanics & Foundations., Firewall Media, 2017 (16th edition)
2. Alam Singh, Modern Geotechnical Engineering., CBS Publishers & Distributors, 2012 (3rd edition)
3. Gopal Ranjan & ASR Rao, Basic & Applied Soil Mechanics. New Age International, 2016 (3rd edition)
4. S.K Grag, Geotechnical Engineering., Khanna Publishers, 2016 (10th edition)

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**Civil Engineering, VII-Semester**

**Departmental Elective CE 702(A) Prestressed Concrete Structures**

**Unit I**

**Introduction – Theory and Behaviour:** Basic concepts – Advantages – Materials required – Systems and methods of prestressing – Analysis of sections – Stress concept – Strength concept – Load balancing concept – Effect of loading on the tensile stresses in tendons – Effect of tendon profile on deflections – Factors influencing deflections – Calculation of deflections – Short term and long term deflections – Losses of prestress – Estimation of crack width.

**Unit II**

**Design for Flexure and Shear:** Basic assumptions for calculating flexural stresses – Permissible stresses in steel and concrete as per I.S.1343 Code – Design of sections of Type I and Type II post-tensioned and pre-tensioned beams – Check for strength limit based on I.S. 1343 Code – Layout of cables in post-tensioned beams – Location of wires in pre-tensioned beams – Design for shear based on I.S. 1343 Code.

**Unit III**

**Deflection and Design of Anchorage Zone:** Factors influencing deflections – Short term deflections of uncracked members – Prediction of long term deflections due to creep and shrinkage – Check for serviceability limit state of deflection. Determination of anchorage zone stresses in post-tensioned beams by Magnel's method, Guyon's method and IS1343 code – design of anchorage zone reinforcement – Check for transfer bond length in pre-tensioned beams.

**Unit IV**

**Composite and Continuous Beams and Slabs:** Analysis and design of composite beams – Methods of achieving continuity in continuous beams – One and two way slabs, flat slab. Analysis for secondary moments – Concordant cable and linear transformation – Calculation of stresses – Principles of design.

**Unit V**

**Miscellaneous Structures:** Design of tension and compression members – Tanks, pipes, sleepers and poles – Partial prestressing – Definition, methods of achieving partial prestressing, merits and demerits of partial prestressing.

**References Books:**

1. Krishna Raju N., Prestressd Concrete, Tata Mc Graw Hill Book Co.Ltd. New Delhi.
2. Pandit.G.S. and Gupta.S.P., Prestressed Concrete, CBS Publishers and Distributers Pvt. Ltd.
3. Lin T. Y. and Ned H Burns., Design of Prestressed Concrete Structures, Wiley India Pvt. Ltd.
4. Dayaratran P., Prestressed Concrete Structures, Oxford & IBH Co., Delhi.

5. Rajagopalan.N, "Prestressed Concrete", Narosa Publishing House.
6. IS: 1343, Indian Standard code of Practice for Prestressed Concrete, Bureau of Indian Standards, New Delhi.
7. IS: 784, Indian Standard Specification for Prestressed Concrete Pipes, Bureau of Indian Standards, New Delhi.
8. IS: 3935 - Code of Practice for Composite Construction, Bureau of Indian Standards, New Delhi.

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**Civil Engineering, VII-Semester**

**Departmental Elective CE 702(B) Environmental Engg-II**

**(L-T-P: 3-1-0, Credit: 4)**

**Course Objectives:**

- O1: To design waste-water treatment units by giving fundamental knowledge of primary, secondary and advanced wastewater treatment technologies.
- O2: To learn fundamental concept of Air pollution, its behavior in atmosphere and introduction of Air-pollution chemistry.

**Unit –I: Unit operations for waste-water treatment**

Theory and design of preliminary treatment such as screens, grit chamber, sedimentation and chemical clarification, role of micro-organism in biological treatment.

**Unit - II: Biological Treatment of waste-water**

Methods of Biological Treatment (Theory & Design) –Trickling Filter, Activated Sludge process (ASP), Oxidation ditch, Septic tank & Imhoff tank, theory of sludge.

**Unit – III: Advanced Waste-water treatment**

Diatomaceous earth filters, Ultrafiltration, Adsorption by activated carbon, Phosphorus removal, Nitrogen removal.

**UNIT IV: Introduction of Air pollution**

Definition, Sources, classification and characterization of air pollutants. Effects of air pollution on health, vegetation & materials, photochemical smog.

**UNIT V: Air pollution chemistry**

meteorological aspects of air pollution dispersion; temperature lapse rate and stability, wind velocity and turbulence, plume behaviour, dispersion of air pollutants, the Gaussian Plume Model.

**Course Outcomes:**

At the end of the course, students would be able to

- CO1:** Carry out municipal wastewater treatment system design and operation.
- CO2:** Analyze and design of biological treatment plant, ponds, and various tanks.
- CO3:** Apply knowledge of environmental treatment technologies and design processes.
- CO4:** Apply knowledge of Air pollution and Air-pollution chemistry.

**Reference Books:**

1. Water Supply & Sanitary Engg. - G.S. Birdie - Dhanpat Rai Publishing Company, 2. (P) Ltd. New Delhi
3. Waste Water Engg. by B.C. Punmia - Laxmi Publication (P) Ltd. New Delhi
4. Environmental Engg. - M.L. Davis & D.A. Cornwell - Mc Graw Hill Company
5. Chemistry for Environmental Engg. - Sawyer & Mc Carty - Mc Graw Hill Book Company New Delhi
6. Water & Waste Water Technology - Mark J Hammer - Prentice - Hall of India, New Delhi
7. Waste Water Engineering - Metcalf & Eddy - Mc Graw Hill Book Company New Delhi

### Course Objective

The objective of the course is to understand the behavior of structure to various dynamic loads.

### Course

### Contents

#### Unit 1

#### Undamped Single Degree of Freedom System

Degree of freedom, undamped system, Force displacement relation, damping force, Equation of motion, mass-spring damper system, D'Alembert's Principle, Solution of differential equation of motion, frequency, period and amplitude of motion.

#### Unit-2

#### Damped Single Degree of Freedom System

Viscous damping, equation of motion, critically damped systems, over and under damped systems, logarithmic decrement.

#### Unit-3

#### Response to harmonic and periodic vibrations

Harmonic vibration of undamped and viscously damped systems, natural frequency and damping, force transmission and vibration isolation, Fourier series representation, response to periodic force.

#### Unit-4

#### Response to Arbitrary, Step, and Pulse Excitation

Response to unit impulse, arbitrary force, Duhamel's Integral, step force, rectangular pulse force, half cycle sinusoidal pulse force, triangular pulse force.

#### Unit-5

#### Multi Degree of Freedom System:

Matrix formulation, stiffness and flexibility influence coefficients, eigen value problem, normal modes and their properties. Matrix iteration technique for eigen value, and eigen vectors, Free and forced vibration by modal analysis.

### Course Outcome

The students will learn the effect of dynamic loading on the structure and its analysis.

**Evaluation:** Evaluation will be continuous and integral part of the class followed by final

examination. **Reference Books:**

1. Chopra A. K., Dynamics of Structures, Prentice Hall of India, NewDelhi,
2. Clough R.W., Penzien J., Dynamics of structures, McGraw-Hill
3. Biggs J M, Introduction to StructuralDynamics
4. Mario Paz, Structural Dynamics, CBS publishers NewDelhi

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**Civil Engineering, VII-Semester**

**Departmental Elective CE 702(D) Structural Design and Drawing (RCC-II)**

**Unit – I**

Design of Multistory Buildings - Sway and nonsway buildings, Shear walls and other bracing elements.

**Unit II**

Design of Earth Retaining Structures: Cantilever and counter fort types retaining walls.

**Unit - III**

Water Tanks: Tanks on ground and underground tanks: Square, rectangular, circular tanks, Overhead tanks: square, rectangular, circular & intze tanks.

**Unit – IV**

Design of Silos and Bunkers

**Unit - V**

T-beam & Slab bridges- for highway loading (IRC Loads). Prestressing concepts materials, systems of prestressing & losses Introduction to working & limit State Design.

Suggested Books: - 1. R.C.C. by O.P. Jain Vol. II

2. R.C.C. by B.C. Punmia

3. Essentials of Bridge engineering – D.J. Victor

4. Bridge Engineering – Ponnuswamy

5. Advanced R.C.C. Design by N.K. RAJU

6. N.Krishna Raju, Prestressed Concrete, Tata Mc Graw Hill, New Delhi.

7. Pre stresses concrete – T.Y. Lin

# RAJIV GANDHI PROUDYOGIKI VISHWAVIDYALAYA, BHOPAL

## New Scheme Based On AICTE Flexible Curricula

### Civil Engineering, VII-Semester

#### Open Elective CE 703(A) Internet of Things

##### Course Objectives (CEO):

The course provides basic knowledge of how to connect various devices through Internet and control them remotely. It will provide methods for different types of networking and data storage. The course aims at providing communication overview and protocols for safe and secure data access and transfer and maintain confidentiality and integrity.

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**Unit 1:** Introduction: Definition, Characteristics of IOT, IOT Conceptual framework, IOT Architectural view, Physical design of IOT, Logical design of IOT, Application of IOT.

**Unit 2:** Machine-to-machine (M2M), SDN (software defined networking) and NFV (network function virtualization) for IOT, data storage in IOT, IOT Cloud Based Services.

**Unit 3:** Design Principles for Web Connectivity: Web Communication Protocols for connected devices, Message Communication Protocols for connected devices, MQTT, CoAP, SOAP, REST, HTTP Restful and Web Sockets.

Internet Connectivity Principles: Internet Connectivity, Internet based communication, IP addressing in IOT, Media Access control.

**Unit 4:** Sensor Technology, Participatory Sensing, Industrial IOT and Automotive IOT, Actuator, Sensor data Communication Protocols, Radio Frequency Identification Technology, Wireless Sensor Network Technology.

**Unit 5:** IOT Design methodology: Specification -Requirement, process, model, service, functional & operational view. IOT Privacy and security solutions, Raspberry Pi & Arduino devices. IOT Case studies: smart city streetlights control & monitoring.

##### Reference Book:

1. Rajkamal, "Internet of Things", Tata McGraw Hill publication
2. Vijay Madiseti and Arshdeep Bahga, "Internet of things (A-Hand-on-Approach)" 1st Edition, Universal Press
3. Charles Bell "MySQL for the Internet of things", Apress publications.
4. Francis dacosta "Rethinking the Internet of things: A scalable Approach to connecting everything", 1st edition, Apress publications.
5. Hakima Chaouchi "The Internet of Things: Connecting Objects", Wiley publication.
6. Donald Norris "The Internet of Things: Do-It-Yourself at Home Projects for Arduino, Raspberry Pi and BeagleBone Black", McGraw Hill publication.

**Course Outcomes (COs):** After completion of the course the students should be able to

1. Understand in depth about Internet of things.
2. Establish secure communication for his network for his devices connected in IOT.
3. Store his data securely on cloud and access it when required
4. Design web based application using various internet protocols and services
5. Use sensor technology and RFID and wireless networking for maintaining privacy and security concern in smart city and housing environmental considerations.

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**Civil Engineering, VII-Semester**

**Open Elective CE 703(B) Project Management**

**Course Objectives:**

The objectives of this course are :

1. To make them understand the concepts of Project Management for planning, resource utilization to execution of projects.
2. To make them understand the feasibility analysis in Project Management, earned value, risk and time estimation.
3. To enable them to comprehend the fundamentals of Project life cycle, Costing and Budgeting.
4. Make them capable to analyze, apply and appreciate contemporary project management tools and project proposal, documentation and team management.

**UNIT 1**

**Project Management Concepts &Initiating**

Project Attributes , Balancing Project Constraints, Project Life Cycle  
Project Management Process, Stakeholder Engagement , Global Project Management , Benefits .Project Identification, Project Selection

**UNIT 2 Developing Project Proposals**

Building Relationships with Customers and Partners, Pre-RFP/Proposal Marketing  
Decision to Develop a Proposal &techniques ,Proposal Preparation & Contents  
Pricing Considerations , Contracts

**UNIT 3 Planning Schedule, & Resource Utilization-Its Performance , and Controlling the Project**

Project Objective ,scope, Plan for Quality , Create W.B.S, Assign Responsibility, Activities & sequencing ,Estimate Activity Resources & Durations ,Develop Project Schedule , Project Control Process ,Resource-Constrained Planning ,leveling, scheduling  
Project Management Information Systems

**Unit 4 Determining Costs, Budget, and Earned Value & Risks**

Estimate Activity Costs Determine Project Budget , Determine Actual Cost  
Determine Value of Work Performed Analyze Cost Performance , Control Costs ,Manage Cash Flow, Identify Risks, Assess Risks ,Monitor Risks

**Unit 5 The Project Team &Project Manager & Documentations& project Management structures**

Acquiring the Project Team, Project Team Development,Project Kickoff Meeting  
Project Manager Responsibilities, Project Manager Skills ,Developing Project Manager Competence ,Delegation &Managing Changes,  
Functional Organizational Structure ,Matrix Organizational Structure  
Advantages and Disadvantages of Organizational Structures

**Course Outcomes:**

On completion of this course, the students will be able to:

1. Understand project characteristics and various stages of a project.
2. Understand the conceptual clarity about project organization and feasibility analyses – Market, Technical, Financial and Economic.
3. Analyze the learning and understand techniques for Project planning, scheduling and Execution Control.
4. Apply the risk management plan and analyse the role of stakeholders.
5. Understand the contract management, Project Procurement and productivity.
6. Understand the Documentation and Control are practiced in the industry

**References:**

1. Contemporary Project Management, 4E by Timothy J. Kloppenborg | Vittal S. Anantatmula | Kathryn Wells Cengage Learning India
2. Project Management: The Managerial Process, 6E by Clifford F. Gray, Erik W. Larson, Gautam V. Desai McGraw Hill
3. Project Management, 1E by Pradeep Pai. Pearson
4. Project Management: A Systems Approach to Planning, Scheduling, and Controlling, 12th Edition by Harold Kerzner. Wiley
5. Project Management A practical guide to planning and managing Projects by Stephen Hartley. Taylor & Francis

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**Civil Engineering, VII-Semester**

**Open Elective CE 703(C) Integrated Waste Management**

**(L-T-P: 3-0-0, Credit: 3)**

**Course Objectives:**

- O1: To Aware about the problems associated with Municipal solid waste(MSW) and their effective management.
- O2: To understand the components of Integrated solid waste management system.
- O3: To learn about recycling, reuse and reduce, recover of solid wastes and Transfer station.
- O4: To examine the operation of a resource recovery facility, waste-to-energy strategies.
- O5: To study the design and operation of a municipal solid waste composting and land-filling.

**UNIT I: INTRODUCTION OF SOLID WASTES**

Definition of solid waste, garbage, rubbish-Sources and Types of solid wastes. Characteristics of Solid Wastes: Physical, chemical and biological characteristics- Problems occur due to improper disposal of solid wastes.

**UNIT II: INTEGRATED SOLID WASTE MANAGEMENT**

Definition- Reduction, reuse, recycling and recovery principles of waste management- Functional elements of integrated solid Waste management- Waste generation and handling at Source-Collection of solid wastes- Collection methods and services- guidelines for collection route layout.

**UNIT III: INTRODUCTION OF TRANSFER STATION**

Transfer Station-Processing and segregation of the solid waste- various methods of material segregation. Importance of Transfer Stations. Site selection of transfer stations.

**UNIT IV: PROCESSING AND TRANSFORMATION OF SOLID WASTES**

Composting: definition-methods of composting-advantages of composting, Incineration: definition-methods of incineration-advantages and disadvantages of incineration.

**UNIT V: DISPOSAL OF SOLID WASTE**

Volume reduction, Open dumping, land filling techniques. Landfills: Classification-Design and Operation of landfills, Land Farming, Deep well injection.

**Course Outcomes:**

After studying this course, students will be able to:

CO1: Review the components of solid waste management system as per need of particular locality, town or city.

CO2: Be aware of the significance of recycling, reuse and reduction and recovery of solid wastes.

CO3: Develop an insight into the collection, transfer, and transport of municipal solid waste.

CO4: Understand the importance and operation of a resource recovery facilities like waste-to-energy Technologies-Biochemical and thermochemical.

CO5: Understand the design and operation of a municipal solid waste composting and landfilling.

**Text Books:**

1. George Tchobanoglous, Hilary Theisen and Samuel A Vigil, Integrated Solid Waste management, Tata McGraw Hill
2. Ramachandra T.V., Management of Municipal Solid Waste, 2009; by The Energy and Resource Institute, TERI
3. Sasikumar, K, Gopi Krishna, Sanoop, Solid Waste Management; 2009, PHI.

**Reference Books:**

1. Manual on Solid Waste Management, prepared by The Central Public Health and Environmental Engineering Organization(CPHEEO), India
2. MSW Management Rules 2016, Govt. of India, available online at CPCB website

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## **New Scheme Based On AICTE Flexible Curricula**

### **Civil Engineering, VII-Semester**

#### **Open Elective CE 703(D) Building Services**

##### **UNIT I -**

Importance of building services, types of services required in building complexes. Planning of services, organization structure of services role and administrative functions of supervisors, classification of building as per NBC. Water supply & distributions in high rise buildings, house connections system of water supply, water supply fixtures & appliances, swimming pool water treatment, algae control in swimming pool.

##### **UNIT II – Lift & Escalator**

Anatomy of lift provision in lift, classification of lift, types of lifts, types of operation of lifts. lift codes & rules, traffic analysis and selection of lift, types of lift control, structural provisions of lift and buildings, fire safety provisions in lifts, work done and lift installation by owner, details of information to be given to lift supplier, Accidents in lifts and safety precautions, escalators, working mechanism, Travelators,

##### **UNIT III – Fire-Fighting**

Fire growth and behavior, classification of fire, fire triangle classification of building according to fire, classification of structural components, modes of fire, fire- extinguishers and their types of suitability, types of portable fire extinguishers, fire hydrants and their location, Carbon Di-oxide storing system , provisions in building from fire safety (IS 1641), Hydrants installation , fire lift , fire escapes, service duet escape route , fire detection systems their type and applications fire alarm systems, types and their working fire control systems.

##### **UNIT IV – Acoustics and sound insulation and HVAC system**

Noise, sources & their effects, Characteristics sound; Acoustical defects, Noise in building, Planning Noise rating Curve, Reverberation time, materials for acoustical treatment, requirement for good acoustics, general principles of caustics design, Acoustical design of auditorium, studio, open air theatre, Sound insulation of walls, ceiling floors.

Natural ventilation, Types of Ventilation systems, Types of air conditioning, principles of control air conditioning, system of air conditioning essentials of air conditioning system, Thermal insulation of walls & ceiling, methods of thermal insulation.

##### **UNIT V – Miscellaneous Services**

Building Security & access Control (Biometrics, voice recognition, Iris detector, smart card, Vascular pattern, fingerprint, contactless system etc), Design of car parking system, car park management Strategy , services for Disabled , Rain water harvesting, solar systems, green Building Concerns, Street lighting (Campus lighting), Land scaping & Horticulture, waste collection & reuse & recycling, package STP, use of IOT in building Services management, CCTV, Surveillance, refuse collection & Transportation

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**Civil Engineering, VII-Semester**

**CE704- Prestressed Concrete Structures Lab**

**Prestressed Concrete Design**

**List of Tutorials:**

Based on Syllabus students shall perform following.

1. Fabrication, casting and testing of simply supported prestressed concrete beam/slab (pres-tensioned or post-tensioned) for strength and deflection behaviour.
2. Fabrication, casting and testing of beam/slab (pres-tensioned or post-tensioned) with different layout of cables for strength and deflection behaviour
3. Fabrication, casting and testing of various prestressed structures as per contents given in the syllabus
4. Minimum 15 problems from above topics along with cross checking using any open-source / professional software.
5. Modeling and analysis of at least one real-life structure using open-source/ professional software

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**Civil Engineering, VII-Semester**

**CE705- IOT Lab**

**List of Experiments**

LAB INDEX Design, Developed and implement following using Arduino, Raspberry Pi compiler and Python language in Linux/Windows environment.

1. Study and Install IDE of Arduino and different types of Arduino.
2. Write program using Arduino IDE for Blink LED.
3. Write Program for RGB LED using Arduino.
4. Study the Temperature sensor and Write Program for monitor temperature using Arduino.
5. Study and Implement RFID, NFC using Arduino.
6. Study and Configure Raspberry Pi.
7. WAP for LED blink using Raspberry Pi.
8. Study and Implement Zigbee Protocol using Arduino / Raspberry Pi.
9. Study and implement MQTT protocol using Arduino.
10. Study and implement CoAP protocol using Arduino.