Department of Civil Engineering

Course File

PROJECT MANAGEMENT
(Course Code: CE8310E)

IV B.Tech II Semester

2023-24

Mr.K. Upendar
Assistant Professor

Ananthagiri, Kodad, Telangana 508 206, India.

Department of Civil Engineering

PROJECT MANAGEMENT

Check List

Department of Civil Engineering

Int. Marks: 25 Ext. Marks: 75 Total Marks:100

IV Year B.Tech. CE - II Sem **L T/P/D C**
3 0 3

(CE831OE) PROJECT MANAGEMENT
(OPEN ELECTIVE-III)

UNIT I

Fundamentals of construction technology: Construction activities – Process – Construction schedule – Construction records – Documents – Quality – Safety – Codes and regulations - Construction method – Earthwork – Piling – Concrete and concreting – Form work – Fabrication and erection.

UNIT II

Mechanized construction: Construction equipment – Equipment economics – Excavators – Rollers – Dozers – Scrapers – Handling equipment – Concrete equipment – Handling equipment – Cranes Draglines and Clamshells.

UNIT III

Quality control: Assurance and safety – ISO-900 Quality systems – Principles on safety – Personnel, Fire and Safety – Environment protection – Concept of green building.

UNIT IV

Contract management: Project estimation – Project estimation – Contract document – Classification – Bidding – Procurement process. Construction planning – Project planning techniques – Planning of man power – Material, Equipment and Finance.

UNIT V

Project scheduling: PERT – CPM, Resource levelling, Construction claims, Dispute and Project closure – Source of claim – Claim management – Dispute resolution – Arbitration – Construction closure – Contract closure – Documentation.

Text Books:

1. Construction Technology by subir k Sarkar, Subhajit Saraswati / Oxford University Press 2009
2. Construction Project Management – Theory and practice, Nirajjha Pearson Education 2010.

Reference Book:

1. Construction planning, Equipment and Methods by Peurifacy. Schexnayder Shapira TMH, 2010.

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Timetable

IV B.Tech. II Semester – (ECE A & B Sections and CSE A Sec)

Day/Hour	9:30-10:20	10:20-11:10	11:20-12:10	12:10-1:00	1:40-2:25	2:25-3:10	3:15-4:00
Monday	IV ECE-A	IV ECE-B				IV CSE-A	IV CSE-A
Tuesday	IV ECE-B	IV ECE-A					IV CSE-A
Wednesday	IV ECE-A	IV ECE-B					IV CSE-A
Thursday	IV ECE-B	IV ECE-A					
Friday	IV ECE-A	IV ECE-B				IV CSE-A	
Saturday	IV ECE-B	IV ECE-A			IV CSE-A		

Department of Civil Engineering

Vision of the Institute

To be a premier Institute in the country and region for the study of Engineering, Technology and Management by maintaining high academic standards which promotes the analytical thinking and independent judgment among the prime stakeholders, enabling them to function responsibly in the globalized society.

Mission of the Institute

To be a world-class Institute, achieving excellence in teaching, research and consultancy in cutting-edge Technologies and be in the service of society in promoting continued education in Engineering, Technology and Management.

Quality Policy

To ensure high standards in imparting professional education by providing world-class infrastructure, top-quality-faculty, and decent work culture to sculpt the students into Socially Responsible Professionals through creative team-work, innovation, and research.

Vision of the Department

To impart knowledge, skill, and excellence in civil engineering with a global perspective to enable the students as competent, qualitative & ethically strong engineers with an intuition to improve quality of life for the benefit of the society.

Mission of the Department

- To train the students in the civil engineering domain.
- To develop knowledge and skill to solve regional and global problems.
- To transform into qualitative and ethically strong professional engineers through research and Development.

Department of Civil Engineering

Program Educational Objectives (B.Tech. – CE)

Graduates will be able to

PEO1: To provide knowledge in mathematics, science, and engineering principles for a successful Career in sectors of civil engineering and allied industry and/or higher education.
PEO2: To develop an ability to identify, formulate, solve problems along with adequate analysis, Design, synthesizing and interpretation skills in civil engineering systems.
PEO3: To exhibit professionalism, ethics, communication skills and team work in their profession and engagedin lifelong learning of contemporary civil engineering trends.

Program Outcomes (B.Tech. – CE)

At the end of the Program, a graduate will have the ability to

PO 1: An ability to apply knowledge of mathematics, science, and engineering
PO 2: An ability to design and conduct experiments, as well as to analyze and interpret data
PO 3: An ability to design a system, component, or process to meet desired needs within realistic constraints such as economic, environmental, social, political, ethical, health and safety, manufacturability
PO 4: An ability to function on multidisciplinary teams
PO 5: An ability to identify, formulates, and solves engineering problems
PO 6: An understanding of professional and ethical responsibility
PO 7: An ability to communicate effectively
PO 8: The broad education necessary to understand the impact of engineering solutions in a global, economic, environmental, and societal context
PO 9: A recognition of the need for, and an ability to engage in lifelong learning
PO 10: Knowledge of contemporary issues.
PO 11: An ability to use the techniques, skills, and modern engineering tools necessary for engineering practice
PO 12: An ability to carry out research in different areas of Civil Engineering including latest technology like GIS/Remote Sensing resulting in design, development, analyze and journal publications and technology development.

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COURSE OBJECTIVES

On completion of this Subject/Course the student shall be able to:

S.No	Objectives
1	To understand the concept of construction technology activities & their documents.
2	To study about mechanized constructions & equipment.
3	To know about the quality control, assurance and safety.
4	To know the importance of contract management & project estimations.
5	To understand project scheduling and their relevant documents.

COURSE OUTCOMES

The expected outcomes of the Course/Subject are:

S.No	Outcomes
1.	Handle the Project work with Proper Planning Scheduling including construction methods
2.	Use the mechanized construction equipment at different situations or any huge projects
3.	Have the knowledge of ISC -9000 Quality systems and environmental protection.
4.	To classify the contact management, estimation and project planning techniques
5.	Use the CPM – PERT Problems in project scheduling

Signature of faculty

Note: Please refer to Bloom's Taxonomy, to know the illustrative verbs that can be used to state the outcomes.

Department of Civil Engineering

GUIDELINES TO STUDY THE COURSE / SUBJECT

Course Design and Delivery System (CDD):

- The Course syllabus is written into number of learning objectives and outcomes.
- Every student will be given an assessment plan, criteria for assessment, scheme of evaluation and grading method.
- The Learning Process will be carried out through assessments of Knowledge, Skills and Attitude by various methods and the students will be given guidance to refer to the text books, reference books, journals, etc.

The faculty be able to –

- Understand the principles of Learning
- Understand the psychology of students
- Develop instructional objectives for a given topic
- Prepare course, unit and lesson plans
- Understand different methods of teaching and learning
- Use appropriate teaching and learning aids
- Plan and deliver lectures effectively
- Provide feedback to students using various methods of Assessments and tools of Evaluation
- Act as a guide, advisor, counselor, facilitator, motivator and not just as a teacher alone

Signature of HOD

Date:

Signature of faculty

Date:

Department of Civil Engineering

COURSE SCHEDULE

The Schedule for the whole Course / Subject is:

S. No.	Description	Duration (Date)		Total No. of Periods
		From	To	
1.	**UNIT-I:** Fundamentals of construction technology- Construction activities – Process – Construction schedule – Construction records – Documents – Quality – Safety – Codes and regulations. Construction method – Earthwork – Piling – Concrete and concreting – Form work – Fabrication and erection.	15.11.2023	05.12.2023	16
2.	**UNIT-II:** Mechanized construction – Construction equipment – Equipment economics – Excavators – Rollers – Dozers – Scrapers – Handling equipment – Concrete equipment – Handling equipment – Cranes Draglines and Clamshells.	06.12.2023	27.12.2023	15
3.	**UNIT-III:** Quality control – Assurance and safety – ISO-900 Quality systems – Principles on safety – Personnel, Fire and Safety – Environment protection – Concept of green building.	29.12.2023	23.01.2024	14
4.	**UNIT-IV:** Contract management – Project estimation – Project estimation – Contract document – Classification – Bidding – Procurement process. Construction is planning – Project planning techniques – Planning of man power – Material, Equipment and Finance.	24.01.2024	12.02.2024	15
5.	**UNIT-V:** Project scheduling – PERT – CPM, Resource leveling, Construction claims, Dispute and Project closure – Source of claim – Claim management – Dispute resolution – Arbitration – Construction closure – Contract closure – Documentation.	13.02.2024	03.04.2024	17

Total No. of Instructional periods available for the course: **77 Hours**

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SCHEDULE OF INSTRUCTIONS - COURSE PLAN

Unit No.	Lesson No.	Date	No. of Periods	Topics / Sub-Topics	Objectives & Outcomes Nos.	References (Textbook, Journal)
1.	1	15.11.2023	1	Introduction to Project Management	1, 2, 3, 4, 5 1, 2, 3, 4, 5	Construction Technology by subir k Sarkar & Construction Project Management Theory and practice, Nirajjha Pearson
	2	17.11.2023	1	**UNIT-I:** Introduction to fundamentals of construction technology	1 1	Construction Technology by subir k Sarkar & Construction Project Management Theory and practice, Nirajjha Pearson
	3	18.11.2023	1	Construction activities	1 1	Construction Technology by subir k Sarkar & Construction Project Management Theory and practice, Nirajjha Pearson
	4	20.11.2023	2	Steps involved in construction process	1 1	Construction Technology by subir k Sarkar & Construction Project Management Theory and practice, Nirajjha Pearson
	5	21.11.2023	1	Scheduling of construction	1 1	Construction Technology by subir k Sarkar & Construction Project Management Theory and practice, Nirajjha Pearson
	6	22.11.2023	1	Records at construction site	1 1	Construction Technology by subir k Sarkar & Construction Project Management Theory and practice, Nirajjha Pearson
	7	24.11.2023	1	Construction documents	1 1	Construction Technology by subir k Sarkar & Construction Project Management Theory and practice, Nirajjha Pearson
	8	25.11.2023	1	Quality in construction	1 1	Construction Technology by subir k Sarkar & Construction Project Management Theory and practice, Nirajjha Pearson
	9	28.11.2023	1	Safety during construction	1 1	Construction Technology by subir k Sarkar & Construction Project Management Theory and practice, Nirajjha Pearson
	10	29.11.2023	1	Building codes and regulations	1 1	Construction Technology by subir k Sarkar & Construction Project Management Theory and practice, Nirajjha Pearson
	11	01.12.202	1	Construction methods	1	Construction Technology by

		3			1	subir k Sarkar & Construction Project Management Theory and practice, Nirajjha Pearson
	12	02.12.2023	1	Earthwork and excavation	1 1	Construction Technology by subir k Sarkar & Construction Project Management Theory and practice, Nirajjha Pearson
	13	04.12.2023	2	Piling, Concrete and Concreting	1 1	Construction Technology by subir k Sarkar & Construction Project Management Theory and practice, Nirajjha Pearson
	14	05.12.2023	1	Formwork, Fabrication & Erection	1 1	Construction Technology by subir k Sarkar & Construction Project Management Theory and practice, Nirajjha Pearson
2.	1	06.12.2023	1	**Unit-II:** Introduction to Mechanized Construction	2 2	Construction Technology by subir k Sarkar & Construction Project Management Theory and practice, Nirajjha Pearson
	2	08.12.2023	1	Construction equipment	2 2	Construction Technology by subir k Sarkar & Construction Project Management Theory and practice, Nirajjha Pearson
	3	11.12.2023	2	Concept of Equipment economics	2 2	Construction Technology by subir k Sarkar & Construction Project Management Theory and practice, Nirajjha Pearson
	4	12.12.2023	1	Excavators-Types	2 2	Construction Technology by subir k Sarkar & Construction Project Management Theory and practice, Nirajjha Pearson
	5	13.12.2023	1	Excavators-Uses and applications	2 2	Construction Technology by subir k Sarkar & Construction Project Management Theory and practice, Nirajjha Pearson
	6	15.12.2023	1	Rollers-Types	2 2	Construction Technology by subir k Sarkar & Construction Project Management Theory and practice, Nirajjha Pearson
	7	16.12.2023	1	Rollers- Uses & Applications	2 2	Construction Technology by subir k Sarkar & Construction Project Management Theory and practice, Nirajjha Pearson
	8	18.12.2023	2	Dozers-Types, Uses & applications	2 2	Construction Technology by subir k Sarkar & Construction Project Management Theory and practice, Nirajjha Pearson
	9	19.12.202	1	Scrappers- Types,	2	Construction Technology by

		3		Uses & applications	2	subir k Sarkar & Construction Project Management Theory and practice, Nirajjha Pearson
	10	20.12.2023	1	Concrete Equipment	2 2	Construction Technology by subir k Sarkar & Construction Project Management Theory and practice, Nirajjha Pearson
	11	22.12.2023	1	Handling Equipment-Cranes	2 2	Construction Technology by subir k Sarkar & Construction Project Management Theory and practice, Nirajjha Pearson
	12	23.12.2023	1	Handling Equipment-Draglines	2 2	Construction Technology by subir k Sarkar & Construction Project Management Theory and practice, Nirajjha Pearson
	13	27.12.2023	1	Handling Equipment-Clamshells	2 2	Construction Technology by subir k Sarkar & Construction Project Management Theory and practice, Nirajjha Pearson
3.	1	29.12.2023	1	**Unit-III:** Introduction to quality control	3 3	Construction Technology by subir k Sarkar & Construction Project Management Theory and practice, Nirajjha Pearson
	2	30.12.2023	1	Quality assurance & Safety in construction	3 3	Construction Technology by subir k Sarkar & Construction Project Management Theory and practice, Nirajjha Pearson
	3	02.01.2024	1	Difference between QC & QA	3 3	Construction Technology by subir k Sarkar & Construction Project Management Theory and practice, Nirajjha Pearson
	4	03.01.2024	1	ISO-9000 quality systems	3 3	Construction Technology by subir k Sarkar & Construction Project Management Theory and practice, Nirajjha Pearson
	5	05.01.2024	1	Stages in quality control	3 3	Construction Technology by subir k Sarkar & Construction Project Management Theory and practice, Nirajjha Pearson
	6	06.01.2024	1	Principles on safety	3 3	Construction Technology by subir k Sarkar & Construction Project Management Theory and practice, Nirajjha Pearson
	7	08.01.2024	2	Personnel safety at construction site	3 3	Construction Technology by subir k Sarkar & Construction Project Management Theory and practice, Nirajjha Pearson
	8	09.01.202	1	Revision for I Mid	3	Construction Technology by

		4		examination	3	subir k Sarkar & Construction Project Management Theory and practice, Nirajjha Pearson
	9	17.01.2024	1	Fire safety in construction site	3 3	Construction Technology by subir k Sarkar & Construction Project Management Theory and practice, Nirajjha Pearson
	10	19.01.2024	1	Electrical safety in construction site	3 3	Construction Technology by subir k Sarkar & Construction Project Management Theory and practice, Nirajjha Pearson
	11	22.01.2024	2	Environmental protection	3 3	Construction Technology by subir k Sarkar & Construction Project Management Theory and practice, Nirajjha Pearson
	12	23.01.2024	1	Concept of green building	3 3	Construction Technology by subir k Sarkar & Construction Project Management Theory and practice, Nirajjha Pearson
4.	1	24.01.2024	1	**Unit-IV:** Introduction to contract management	4 4	Construction Technology by subir k Sarkar & Construction Project Management Theory and practice, Nirajjha Pearson
	2	27.01.2024	1	Definitions of terms used in contract management	4 4	Construction Technology by subir k Sarkar & Construction Project Management Theory and practice, Nirajjha Pearson
	3	29.01.2024	2	Project estimation, methods of project estimation	4 4	Construction Technology by subir k Sarkar & Construction Project Management Theory and practice, Nirajjha Pearson
	4	30.01.2024	1	Contract document (documents enclosed to contract)	4 4	Construction Technology by subir k Sarkar & Construction Project Management Theory and practice, Nirajjha Pearson
	5	31.01.2024	1	Classification of contracts	4 4	Construction Technology by subir k Sarkar & Construction Project Management Theory and practice, Nirajjha Pearson
	6	02.02.2024	1	Classification of contracts	4 4	Construction Technology by subir k Sarkar & Construction Project Management Theory and practice, Nirajjha Pearson
	7	03.02.2024	1	Bidding process	4 4	Construction Technology by subir k Sarkar & Construction Project Management Theory and practice, Nirajjha Pearson
	8	05.02.202	2	Procurement process	4	Construction Technology by

		4		(Steps involved)	4	subir k Sarkar & Construction Project Management Theory and practice, Nirajjha Pearson
	9	06.02.2024	1	Introduction to Construction planning	4 4	Construction Technology by subir k Sarkar & Construction Project Management Theory and practice, Nirajjha Pearson
	10	07.02.2024	1	Types of construction planning	4 4	Construction Technology by subir k Sarkar & Construction Project Management Theory and practice, Nirajjha Pearson
	11	09.02.2024	1	Project planning techniques	4 4	Construction Technology by subir k Sarkar & Construction Project Management Theory and practice, Nirajjha Pearson
	12	12.02.2024	2	Planning for men, material, finance, and machinery at construction site	4 4	Construction Technology by subir k Sarkar & Construction Project Management Theory and practice, Nirajjha Pearson
5.	1	13.02.2024	1	**Unit-V:** Project Scheduling (Introduction)	5 5	Construction Technology by subir k Sarkar & Construction Project Management Theory and practice, Nirajjha Pearson
	2	14.02.2024	1	Introduction to PERT & CPM, Their difference	5 5	Construction Technology by subir k Sarkar & Construction Project Management Theory and practice, Nirajjha Pearson
	3	16.02.2024	1	Numerical problems on PERT Network technique	5 5	Construction Technology by subir k Sarkar & Construction Project Management Theory and practice, Nirajjha Pearson
	4	17.02.2024	1	Numerical problems on CPM Network technique	5 5	Construction Technology by subir k Sarkar & Construction Project Management Theory and practice, Nirajjha Pearson
	5	19.02.2024	2	Resource leveling and its management	5 5	Construction Technology by subir k Sarkar & Construction Project Management Theory and practice, Nirajjha Pearson
	6	20.02.2024	1	Construction claims, sources of claim	5 5	Construction Technology by subir k Sarkar & Construction Project Management Theory and practice, Nirajjha Pearson
	7	21.02.2024	1	Claim management	5 5	Construction Technology by subir k Sarkar & Construction Project Management Theory and practice, Nirajjha Pearson
	8	22.03.202	1	Disputes and dispute	5	Construction Technology by

		4		resolution methods	5	subir k Sarkar & Construction Project Management Theory and practice, Nirajjha Pearson
	9	23.03.2024	1	Arbitration process	5 5	Construction Technology by subir k Sarkar & Construction Project Management Theory and practice, Nirajjha Pearson
	10	26.03.2024	1	Project Closure- Construction closure	5 5	Construction Technology by subir k Sarkar & Construction Project Management Theory and practice, Nirajjha Pearson
	11	27.03.2024	1	Contract closure, Documentation	5 5	Construction Technology by subir k Sarkar & Construction Project Management Theory and practice, Nirajjha Pearson
	12	30.03.2024	1	Practice on CPM & PERT Network Numerical Problems	5 5	Construction Technology by subir k Sarkar & Construction Project Management Theory and practice, Nirajjha Pearson
	13	01.04.2024	2	Revision for II Mid examination	3,4,5 3,4,5	Construction Technology by subir k Sarkar & Construction Project Management Theory and practice, Nirajjha Pearson
	14	02.04.2024	1	Revision of overall syllabus	1,2,3,4,5 1,2,3,4,5	Construction Technology by subir k Sarkar & Construction Project Management Theory and practice, Nirajjha Pearson
	15	03.04.2024	1	Old Question papers discussions	1,2,3,4,5 1,2,3,4,5	Construction Technology by subir k Sarkar & Construction Project Management Theory and practice, Nirajjha Pearson

Signature of HOD

Signature of faculty

Date:

Date:

Note:

1. Ensure that all topics specified in the course are mentioned.
2. Additional topics covered, if any, may also be specified in bold.
3. Mention the corresponding course objective and outcome numbers against each topic.

Department of Civil Engineering

SCHEDULE OF INSTRUCTIONS – UNIT-I PLAN

Unit No.	Lesson No.	Date	No. of Periods	Topics / Sub-Topics	Objectives & Outcomes Nos.	References (Textbook, Journal)
1.	1	15.11.2023	1	Introduction to Project Management	1, 2, 3, 4, 5 1, 2, 3, 4, 5	Construction Technology by subir k Sarkar & Construction Project Management Theory and practice, Nirajjha Pearson
	2	17.11.2023	1	**UNIT-I:** Introduction to fundamentals of construction technology	1 1	Construction Technology by subir k Sarkar & Construction Project Management Theory and practice, Nirajjha Pearson
	3	18.11.2023	1	Construction activities	1 1	Construction Technology by subir k Sarkar & Construction Project Management Theory and practice, Nirajjha Pearson
	4	20.11.2023	2	Steps involved in construction process	1 1	Construction Technology by subir k Sarkar & Construction Project Management Theory and practice, Nirajjha Pearson
	5	21.11.2023	1	Scheduling of construction	1 1	Construction Technology by subir k Sarkar & Construction Project Management Theory and practice, Nirajjha Pearson
	6	22.11.2023	1	Records at construction site	1 1	Construction Technology by subir k Sarkar & Construction Project Management Theory and practice, Nirajjha Pearson
	7	24.11.2023	1	Construction documents	1 1	Construction Technology by subir k Sarkar & Construction Project Management Theory and practice, Nirajjha Pearson
	8	25.11.2023	1	Quality in construction	1 1	Construction Technology by subir k Sarkar & Construction Project Management Theory and practice, Nirajjha Pearson
	9	28.11.2023	1	Safety during	1	Construction Technology by

				construction	1	subir k Sarkar & Construction Project Management Theory and practice, Nirajjha Pearson
	10	29.11.2023	1	Building codes and regulations	1 1	Construction Technology by subir k Sarkar & Construction Project Management Theory and practice, Nirajjha Pearson
	11	01.12.2023	1	Construction methods	1 1	Construction Technology by subir k Sarkar & Construction Project Management Theory and practice, Nirajjha Pearson
	12	02.12.2023	1	Earthwork and excavation	1 1	Construction Technology by subir k Sarkar & Construction Project Management Theory and practice, Nirajjha Pearson
	13	04.12.2023	2	Piling, Concrete and Concreting	1 1	Construction Technology by subir k Sarkar & Construction Project Management Theory and practice, Nirajjha Pearson
	14	05.12.2023	1	Formwork, Fabrication & Erection	1 1	Construction Technology by subir k Sarkar & Construction Project Management Theory and practice, Nirajjha Pearson

Signature of HOD

Signature of faculty

Date:

Date:

Note:

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Department of Civil Engineering

SCHEDULE OF INSTRUCTIONS – UNIT-II PLAN

Unit No.	Lesson No.	Date	No. of Periods	Topics / Sub-Topics	Objectives & Outcomes Nos.	References (Textbook, Journal)
2.	1	06.12.2023	1	**Unit-II:** Introduction to Mechanized Construction	2 2	Construction Technology by subir k Sarkar & Construction Project Management Theory and practice, Nirajjha Pearson
	2	08.12.2023	1	Construction equipment	2 2	Construction Technology by subir k Sarkar & Construction Project Management Theory and practice, Nirajjha Pearson
	3	11.12.2023	2	Concept of Equipment economics	2 2	Construction Technology by subir k Sarkar & Construction Project Management Theory and practice, Nirajjha Pearson
	4	12.12.2023	1	Excavators-Types	2 2	Construction Technology by subir k Sarkar & Construction Project Management Theory and practice, Nirajjha Pearson
	5	13.12.2023	1	Excavators-Uses and applications	2 2	Construction Technology by subir k Sarkar & Construction Project Management Theory and practice, Nirajjha Pearson
	6	15.12.2023	1	Rollers-Types	2 2	Construction Technology by subir k Sarkar & Construction Project Management Theory and practice, Nirajjha Pearson
	7	16.12.2023	1	Rollers- Uses & Applications	2 2	Construction Technology by subir k Sarkar & Construction Project Management Theory and practice, Nirajjha Pearson
	8	18.12.2023	2	Dozers-Types, Uses & applications	2 2	Construction Technology by subir k Sarkar & Construction Project Management Theory and practice, Nirajjha Pearson
	9	19.12.2023	1	Scrappers- Types,	2	Construction Technology

				Uses & applications	2	by subir k Sarkar & Construction Project Management Theory and practice, Nirajjha Pearson
	10	20.12.2023	1	Concrete Equipment	2 2	Construction Technology by subir k Sarkar & Construction Project Management Theory and practice, Nirajjha Pearson
	11	22.12.2023	1	Handling Equipment-Cranes	2 2	Construction Technology by subir k Sarkar & Construction Project Management Theory and practice, Nirajjha Pearson
	12	23.12.2023	1	Handling Equipment-Draglines	2 2	Construction Technology by subir k Sarkar & Construction Project Management Theory and practice, Nirajjha Pearson
	13	27.12.2023	1	Handling Equipment-Clamshells	2 2	Construction Technology by subir k Sarkar & Construction Project Management Theory and practice, Nirajjha Pearson

Signature of HOD

Signature of faculty

Date:

Date:

Note:

1. Ensure that all topics specified in the course are mentioned.
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3. Mention the corresponding course objective and outcome numbers against each topic.

Department of Civil Engineering

SCHEDULE OF INSTRUCTIONS – UNIT-III PLAN

Unit No.	Lesson No.	Date	No. of Periods	Topics / Sub-Topics	Objectives & Outcomes Nos.	References (Textbook, Journal)
3.	1	29.12.2023	1	**Unit-III:** Introduction to quality control	3 3	Construction Technology by subir k Sarkar & Construction Project Management Theory and practice, Nirajjha Pearson
	2	30.12.2023	1	Quality assurance & Safety in construction	3 3	Construction Technology by subir k Sarkar & Construction Project Management Theory and practice, Nirajjha Pearson
	3	02.01.2024	1	Difference between QC & QA	3 3	Construction Technology by subir k Sarkar & Construction Project Management Theory and practice, Nirajjha Pearson
	4	03.01.2024	1	ISO-9000 quality systems	3 3	Construction Technology by subir k Sarkar & Construction Project Management Theory and practice, Nirajjha Pearson
	5	05.01.2024	1	Stages in quality control	3 3	Construction Technology by subir k Sarkar & Construction Project Management Theory and practice, Nirajjha Pearson
	6	06.01.2024	1	Principles on safety	3 3	Construction Technology by subir k Sarkar & Construction Project Management Theory and practice, Nirajjha Pearson
	7	08.01.2024	2	Personnel safety at construction site	3 3	Construction Technology by subir k Sarkar & Construction Project Management Theory and practice, Nirajjha Pearson
	8	09.01.2024	1	Revision for I Mid examination	3 3	Construction Technology by subir k Sarkar & Construction Project Management Theory and practice, Nirajjha Pearson
	9	17.01.2024	1	Fire safety in construction site	3 3	Construction Technology by subir k Sarkar & Construction Project Management Theory and practice, Nirajjha Pearson
	10	19.01.2024	1	Electrical safety in construction site	3 3	Construction Technology by subir k Sarkar & Construction Project Management Theory and practice, Nirajjha Pearson

	11	22.01.2024	2	Environmental protection	3 3	Construction Technology by subir k Sarkar & Construction Project Management Theory and practice, Nirajjha Pearson
	12	23.01.2024	1	Concept of green building	3 3	Construction Technology by subir k Sarkar & Construction Project Management Theory and practice, Nirajjha Pearson

Signature of HOD

Signature of faculty

Date:

Date:

Note:

1. Ensure that all topics specified in the course are mentioned.
2. Additional topics covered, if any, may also be specified in bold.
3. Mention the corresponding course objective and outcome numbers against each topic.

Department of Civil Engineering

SCHEDULE OF INSTRUCTIONS – UNIT-IV PLAN

Unit No.	Lesson No.	Date	No. of Periods	Topics / Sub-Topics	Objectives & Outcomes Nos.	References (Textbook, Journal)
4.	1	24.01.2024	1	**Unit-IV:** Introduction to contract management	4 4	Construction Technology by subir k Sarkar & Construction Project Management Theory and practice, Nirajjha Pearson
	2	27.01.2024	1	Definitions of terms used in contract management	4 4	Construction Technology by subir k Sarkar & Construction Project Management Theory and practice, Nirajjha Pearson
	3	29.01.2024	2	Project estimation, methods of project estimation	4 4	Construction Technology by subir k Sarkar & Construction Project Management Theory and practice, Nirajjha Pearson
	4	30.01.2024	1	Contract document (documents enclosed to contract)	4 4	Construction Technology by subir k Sarkar & Construction Project Management Theory and practice, Nirajjha Pearson
	5	31.01.2024	1	Classification of contracts	4 4	Construction Technology by subir k Sarkar & Construction Project Management Theory and practice, Nirajjha Pearson
	6	02.02.2024	1	Classification of contracts	4 4	Construction Technology by subir k Sarkar & Construction Project Management Theory and practice, Nirajjha Pearson
	7	03.02.2024	1	Bidding process	4 4	Construction Technology by subir k Sarkar & Construction Project Management Theory and practice, Nirajjha Pearson
	8	05.02.2024	2	Procurement process (Steps involved)	4 4	Construction Technology by subir k Sarkar & Construction Project Management Theory and practice, Nirajjha Pearson
	9	06.02.2024	1	Introduction to Construction planning	4 4	Construction Technology by subir k Sarkar & Construction Project Management Theory and practice, Nirajjha Pearson
	10	07.02.2024	1	Types of construction planning	4 4	Construction Technology by subir k Sarkar & Construction Project Management Theory and practice, Nirajjha Pearson

Department of Civil Engineering

	11	09.02.2024	1	Project planning techniques	4 4	Construction Technology by subir k Sarkar & Construction Project Management Theory and practice, Nirajjha Pearson
	12	12.02.2024	2	Planning for men, material, finance, and machinery at construction site	4 4	Construction Technology by subir k Sarkar & Construction Project Management Theory and practice, Nirajjha Pearson

Signature of HOD

Signature of faculty

Date:

Date:

Note:

1. Ensure that all topics specified in the course are mentioned.
2. Additional topics covered, if any, may also be specified in bold.
3. Mention the corresponding course objective and outcome numbers against each topic.

Department of Civil Engineering

SCHEDULE OF INSTRUCTIONS – UNIT-V PLAN

Unit No.	Lesson No.	Date	No. of Periods	Topics / Sub-Topics	Objectives & Outcomes Nos.	References (Textbook, Journal)
5.	1	13.02.2024	1	**Unit-V:** Project Scheduling (Introduction)	5 5	Construction Technology by subir k Sarkar & Construction Project Management Theory and practice, Nirajjha Pearson
	2	14.02.2024	1	Introduction to PERT & CPM, Their difference	5 5	Construction Technology by subir k Sarkar & Construction Project Management Theory and practice, Nirajjha Pearson
	3	16.02.2024	1	Numerical problems on PERT Network technique	5 5	Construction Technology by subir k Sarkar & Construction Project Management Theory and practice, Nirajjha Pearson
	4	17.02.2024	1	Numerical problems on CPM Network technique	5 5	Construction Technology by subir k Sarkar & Construction Project Management Theory and practice, Nirajjha Pearson
	5	19.02.2024	2	Resource leveling and its management	5 5	Construction Technology by subir k Sarkar & Construction Project Management Theory and practice, Nirajjha Pearson
	6	20.02.2024	1	Construction claims, sources of claim	5 5	Construction Technology by subir k Sarkar & Construction Project Management Theory and practice, Nirajjha Pearson
	7	21.02.2024	1	Claim management	5 5	Construction Technology by subir k Sarkar & Construction Project Management Theory and practice, Nirajjha Pearson
	8	22.03.2024	1	Disputes and dispute resolution methods	5 5	Construction Technology by subir k Sarkar & Construction Project Management Theory and practice, Nirajjha Pearson
	9	23.03.2024	1	Arbitration process	5 5	Construction Technology by subir k Sarkar & Construction Project Management Theory and practice, Nirajjha Pearson
	10	26.03.2024	1	Project Closure-Construction closure	5 5	Construction Technology by subir k Sarkar & Construction Project Management Theory and practice, Nirajjha Pearson

	11	27.03.2024	1	Contract closure, Documentation	5 5	Construction Technology by subir k Sarkar & Construction Project Management Theory and practice, Nirajjha Pearson
	12	30.03.2024	1	Practice on CPM & PERT Network Numerical Problems	5 5	Construction Technology by subir k Sarkar & Construction Project Management Theory and practice, Nirajjha Pearson
	13	01.04.2024	2	Revision for II Mid examination	3,4,5 3,4,5	Construction Technology by subir k Sarkar & Construction Project Management Theory and practice, Nirajjha Pearson
	14	02.04.2024	1	Revision of overall syllabus	1,2,3,4,5 1,2,3,4,5	Construction Technology by subir k Sarkar & Construction Project Management Theory and practice, Nirajjha Pearson
	15	03.04.2024	1	Old Question papers discussions	1,2,3,4,5 1,2,3,4,5	Construction Technology by subir k Sarkar & Construction Project Management Theory and practice, Nirajjha Pearson

Signature of HOD

Signature of faculty

Date:

Date:

Note:

1. Ensure that all topics specified in the course are mentioned.
2. Additional topics covered, if any, may also be specified in bold.
3. Mention the corresponding course objective and outcome numbers against each topic.

Department of Civil Engineering

LESSON PLAN (U-I)

Lesson No: 01, 02 Duration of Lesson: 1hr40 min

Lesson Title: Introduction to Project Management and fundamentals of construction technology

Instructional / Lesson Objectives:

- To make students understand about the fundamentals of construction technology and its activities.
- To familiarize students on construction scheduling and process of construction.
- To understand students the quality and safety during construction and records of construction.
- To provide information on method of construction and concreting and formwork.

Teaching AIDS :PPTs, Digital Board
Time Management of Class :

05 min for taking attendance 80 min for the lecture delivery 15 min for doubts session

Assignment / Questions:
(Note: Mention for each question the relevant Objectives and Outcomes Nos.1, 2, 3, 4& 1, 3.)

Refer assignment – I & tutorial-I sheets

Signature of faculty

Department of Civil Engineering

LESSON PLAN (U-I)

Lesson No: 03, 04 Duration of Lesson: 2hr30 min

Lesson Title: Construction activities, Steps involved in construction process

Instructional / Lesson Objectives:

- To make students understand about the fundamentals of construction technology and its activities.
- To familiarize students on construction scheduling and process of construction.
- To understand students the quality and safety during construction and records of construction.
- To provide information on method of construction and concreting and formwork.

Teaching AIDS :PPTs, Digital Board
Time Management of Class :

10 min for taking attendance 10 min for revision of previous class 120 min for the lecture delivery 10 min for doubts session

Assignment / Questions:
(Note: Mention for each question the relevant Objectives and Outcomes Nos.1,2,3,4 & 1,3..)

Refer assignment – I & tutorial-I sheets

Signature of faculty

Department of Civil Engineering

LESSON PLAN (U-I)

Lesson No: 05, 06 Duration of Lesson: 1hr40 min

Lesson Title: Scheduling of construction, Records at construction site

Instructional / Lesson Objectives:

- To make students understand about the fundamentals of construction technology and its activities.
- To familiarize students on construction scheduling and process of construction.
- To understand students the quality and safety during construction and records of construction.
- To provide information on method of construction and concreting and formwork.

Teaching AIDS :PPTs, Digital Board
Time Management of Class :

05 min for taking attendance 05 min for revision of previous class 80 min for the lecture delivery 10 min for doubts session

Assignment / Questions:
(Note: Mention for each question the relevant Objectives and Outcomes Nos.1,2,3,4 & 1,3..)

Refer assignment – I & tutorial-I sheets

Signature of faculty

Department of Civil Engineering

LESSON PLAN (U-I)

Lesson No: 07, 08 Duration of Lesson: 1hr 40 min

Lesson Title: Construction documents, Quality in construction

Instructional / Lesson Objectives:

- To make students understand about the fundamentals of construction technology and its activities.
- To familiarize students on construction scheduling and process of construction.
- To understand students the quality and safety during construction and records of construction.
- To provide information on method of construction and concreting and formwork.

Teaching AIDS :PPTs, Digital Board
Time Management of Class :

05 min for taking attendance 05 min for revision of previous class 80 min for the lecture delivery 10 min for doubts session

Assignment / Questions:
(Note: Mention for each question the relevant Objectives and Outcomes Nos.1, 2, 3, 4& 1, 3...)

Refer assignment – I & tutorial-I sheets

Signature of faculty

Department of Civil Engineering

LESSON PLAN (U-I)

Lesson No: 09, 10 Duration of Lesson: 1hr 40 min

Lesson Title: Safety during construction, Building codes and regulations

Instructional / Lesson Objectives:

- To make students understand about the fundamentals of construction technology and its activities.
- To familiarize students on construction scheduling and process of construction.
- To understand students the quality and safety during construction and records of construction.
- To provide information on method of construction and concreting and formwork.

Teaching AIDS :PPTs, Digital Board
Time Management of Class :

05 min for taking attendance 05 min for revision of previous class 80 min for the lecture delivery 10 min for doubts session

Assignment / Questions:
(Note: Mention for each question the relevant Objectives and Outcomes Nos.1, 2, 3, 4 & 1, 3...)

Refer assignment – I & tutorial-I sheets

Signature of faculty

Department of Civil Engineering

LESSON PLAN (U-I)

Lesson No: 11, 12 Duration of Lesson: 1hr 40 min

Lesson Title: Construction methods, Earthwork and excavation

Instructional / Lesson Objectives:

- To make students understand about the fundamentals of construction technology and its activities.
- To familiarize students on construction scheduling and process of construction.
- To understand students the quality and safety during construction and records of construction.
- To provide information on method of construction and concreting and formwork.

Teaching AIDS :PPTs, Digital Board
Time Management of Class :

05 min for taking attendance 05 min for revision of previous class 80 min for the lecture delivery 10 min for doubts session

Assignment / Questions:
(Note: Mention for each question the relevant Objectives and Outcomes Nos.1, 2, 3, 4 & 1, 3...)

Refer assignment – I & tutorial-I sheets

Signature of faculty

Department of Civil Engineering

LESSON PLAN (U-I)

Lesson No: 13, 14 Duration of Lesson: 2hr 30 min

Lesson Title: Piling, Concrete and Concreting, Formwork, Fabrication & Erection

Instructional / Lesson Objectives:

- To make students understand about the fundamentals of construction technology and its activities.
- To familiarize students on construction scheduling and process of construction.
- To understand students the quality and safety during construction and records of construction.
- To provide information on method of construction and concreting and formwork.

Teaching AIDS :PPTs, Digital Board
Time Management of Class :

10 min for taking attendance 15 min for revision of previous class 110 min for the lecture delivery 15 min for doubts session

Assignment / Questions:
(Note: Mention for each question the relevant Objectives and Outcomes Nos.1, 2, 3, 4 & 1, 3...)

Refer assignment – I & tutorial-I sheets

Signature of faculty

Department of Civil Engineering

LESSON PLAN (U-II)

Lesson No: 01, 02 Duration of Lesson: 1hr 40 min

Lesson Title: Introduction to Mechanized Construction, Construction equipment

Instructional / Lesson Objectives:

- To make students understand the mechanized construction and equipment economics.
- To familiarize students different construction equipment such as excavators, rollers, dozers.
- To understand students about handling equipment such as cranes, draglines, and clamshells.
- To provide information on concrete equipment used at construction site.

Teaching AIDS :PPTs, Digital Board
Time Management of Class :

05 min for taking attendance
10 min for revision of previous class
80 min for the lecture delivery
05 min for doubts session

Assignment / Questions:
(Note: Mention for each question the relevant Objectives and Outcomes Nos.1, 2, 3, 4 & 1, 3...)

Refer assignment – II& tutorial-II sheets

Signature of faculty

Department of Civil Engineering

LESSON PLAN (U-II)

Lesson No: 03, 04, and 05 Duration of Lesson: 3hr 20 min

Lesson Title: Concept of Equipment economics, Excavators-Types, Excavators-Uses and applications

Instructional / Lesson Objectives:

- To make students understand the mechanized construction and equipment economics.
- To familiarize students different construction equipment such as excavators, rollers, dozers.
- To understand students about handling equipment such as cranes, draglines, and clamshells.
- To provide information on concrete equipment used at construction site.

Teaching AIDS :PPTs, Digital Board
Time Management of Class :

10 min for taking attendance
10 min for revision of previous class
165 min for the lecture delivery
15 min for doubts session

Assignment / Questions:
(Note: Mention for each question the relevant Objectives and Outcomes Nos.1, 2, 3, 4 & 1, 3...)

Refer assignment – II & tutorial-II sheets

Signature of faculty

Department of Civil Engineering

LESSON PLAN (U-II)

Lesson No: 06, 07 Duration of Lesson: 1hr 40 min

Lesson Title: Rollers-Types, Rollers- Uses & Applications

Instructional / Lesson Objectives:

- To make students understand the mechanized construction and equipment economics.
- To familiarize students different construction equipment such as excavators, rollers, dozers.
- To understand students about handling equipment such as cranes, draglines, and clamshells.
- To provide information on concrete equipment used at construction site.

Teaching AIDS :PPTs, Digital Board
Time Management of Class :

10 min for taking attendance 10 min for revision of previous class 165 min for the lecture delivery 15 min for doubts session

Assignment / Questions:
(Note: Mention for each question the relevant Objectives and Outcomes Nos.1, 2, 3, 4 & 1, 3...)

Refer assignment – II & tutorial-II sheets

Signature of faculty

Department of Civil Engineering

LESSON PLAN (U-II)

Lesson No: 08, 09 Duration of Lesson: 2hr 30 min

Lesson Title: Dozers-Types, Uses & applications, Scrappers- Types, Uses & applications

Instructional / Lesson Objectives:

- To make students understand the mechanized construction and equipment economics.
- To familiarize students different construction equipment such as excavators, rollers, dozers.
- To understand students about handling equipment such as cranes, draglines, and clamshells.
- To provide information on concrete equipment used at construction site.

Teaching AIDS :PPTs, Digital Board
Time Management of Class :

10 min for taking attendance
10 min for revision of previous class
120 min for the lecture delivery
10 min for doubts session

Assignment / Questions:
(Note: Mention for each question the relevant Objectives and Outcomes Nos.1, 2, 3, 4 & 1, 3...)

Refer assignment – II & tutorial-II sheets

Signature of faculty

Department of Civil Engineering

LESSON PLAN (U-II)

Lesson No: 10, 11 Duration of Lesson: 1hr 40 min

Lesson Title: Concrete Equipment, Handling Equipment- Cranes

Instructional / Lesson Objectives:

- To make students understand the mechanized construction and equipment economics.
- To familiarize students different construction equipment such as excavators, rollers, dozers.
- To understand students about handling equipment such as cranes, draglines, and clamshells.
- To provide information on concrete equipment used at construction site.

Teaching AIDS :PPTs, Digital Board
Time Management of Class :

05 min for taking attendance 05 min for revision of previous class 80 min for the lecture delivery 10 min for doubts session

Assignment / Questions:
(Note: Mention for each question the relevant Objectives and Outcomes Nos.1, 2, 3, 4 & 1, 3...)

Refer assignment – II & tutorial-II sheets

Signature of faculty

Department of Civil Engineering

LESSON PLAN (U-II)

Lesson No: 12, 13 Duration of Lesson: 1hr 40 min

Lesson Title: Handling Equipment- Draglines & Clamshells

Instructional / Lesson Objectives:

- To make students understand the mechanized construction and equipment economics.
- To familiarize students different construction equipment such as excavators, rollers, dozers.
- To understand students about handling equipment such as cranes, draglines, and clamshells.
- To provide information on concrete equipment used at construction site.

Teaching AIDS :PPTs, Digital Board
Time Management of Class :

05 min for taking attendance 05 min for revision of previous class 80 min for the lecture delivery 10 min for doubts session

Assignment / Questions:
(Note: Mention for each question the relevant Objectives and Outcomes Nos.1, 2, 3, 4 & 1, 3...)

Refer assignment – II & tutorial-II sheets

Signature of faculty

Department of Civil Engineering

LESSON PLAN (U-III)

Lesson No: 01, 02 Duration of Lesson: 1hr 40 min

Lesson Title: Introduction to quality control, Quality assurance & Safety in construction

Instructional / Lesson Objectives:

- To make students understand the concept of quality control, quality assurance and safety.
- To familiarize students about the ISO-9000 quality systems and principles of safety.
- To understand students about personnel safety and fire safety during construction.
- To provide information on environmental protection and concept of green building.

Teaching AIDS :PPTs, Digital Board
Time Management of Class :

05 min for taking attendance 05 min for revision of previous class 80 min for the lecture delivery 10 min for doubts session

Assignment / Questions:
(Note: Mention for each question the relevant Objectives and Outcomes Nos.1, 2, 3, 4 & 1, 3...)

Refer assignment – III & tutorial-III sheets

Signature of faculty

Department of Civil Engineering

LESSON PLAN (U-III)

Lesson No: 03, 04 Duration of Lesson: 1hr 40 min

Lesson Title: Difference between QC & QA, ISO-9000 quality systems

Instructional / Lesson Objectives:

- To make students understand the concept of quality control, quality assurance and safety.
- To familiarize students about the ISO-9000 quality systems and principles of safety.
- To understand students about personnel safety and fire safety during construction.
- To provide information on environmental protection and concept of green building.

Teaching AIDS :PPTs, Digital Board
Time Management of Class :

05 min for taking attendance 05 min for revision of previous class 80 min for the lecture delivery 10 min for doubts session

Assignment / Questions:
(Note: Mention for each question the relevant Objectives and Outcomes Nos.1, 2, 3, 4 & 1, 3...)

Refer assignment – III & tutorial-III sheets

Signature of faculty

Department of Civil Engineering

LESSON PLAN (U-III)

Lesson No: 05, 06 Duration of Lesson: 1hr 40 min

Lesson Title: Stages in quality control, Principles on safety

Instructional / Lesson Objectives:

- To make students understand the concept of quality control, quality assurance and safety.
- To familiarize students about the ISO-9000 quality systems and principles of safety.
- To understand students about personnel safety and fire safety during construction.
- To provide information on environmental protection and concept of green building.

Teaching AIDS :PPTs, Digital Board

Time Management of Class :

05 min for taking attendance 05 min for revision of previous class 80 min for the lecture delivery 10 min for doubts session

Assignment / Questions:
(Note: Mention for each question the relevant Objectives and Outcomes Nos.1, 2, 3, 4 & 1, 3...)

Refer assignment – III & tutorial-III sheets

Signature of faculty

Department of Civil Engineering

LESSON PLAN (U-III)

Lesson No: 07, 08 Duration of Lesson: 2hr 30 min

Lesson Title: Personnel safety at construction site, Revision for I Mid examination

Instructional / Lesson Objectives:

- To make students understand the concept of quality control, quality assurance and safety.
- To familiarize students about the ISO-9000 quality systems and principles of safety.
- To understand students about personnel safety and fire safety during construction.
- To provide information on environmental protection and concept of green building.

Teaching AIDS :PPTs, Digital Board

Time Management of Class :

10 min for taking attendance 10 min for revision of previous class 120 min for the lecture delivery 10 min for doubts session

Assignment / Questions:
(Note: Mention for each question the relevant Objectives and Outcomes Nos.1, 2, 3, 4 & 1, 3...)

Refer assignment – III & tutorial-III sheets

Signature of faculty

Department of Civil Engineering

LESSON PLAN (U-III)

Lesson No: 09, 10 Duration of Lesson: 1hr 40 min

Lesson Title: Fire safety in construction site, Electrical safety in construction site

Instructional / Lesson Objectives:

- To make students understand the concept of quality control, quality assurance and safety.
- To familiarize students about the ISO-9000 quality systems and principles of safety.
- To understand students about personnel safety and fire safety during construction.
- To provide information on environmental protection and concept of green building.

Teaching AIDS :PPTs, Digital Board

Time Management of Class :

05 min for taking attendance 10 min for revision of previous class 80 min for the lecture delivery 05 min for doubts session

Assignment / Questions:
(Note: Mention for each question the relevant Objectives and Outcomes Nos.1, 2, 3, 4 & 1, 3...)

Refer assignment – III & tutorial-III sheets

Signature of faculty

Department of Civil Engineering

LESSON PLAN (U-III)

Lesson No: 11, 12 Duration of Lesson: 2hr 30 min

Lesson Title: Environmental protection, Concept of green building

Instructional / Lesson Objectives:

- To make students understand the concept of quality control, quality assurance and safety.
- To familiarize students about the ISO-9000 quality systems and principles of safety.
- To understand students about personnel safety and fire safety during construction.
- To provide information on environmental protection and concept of green building.

Teaching AIDS :PPTs, Digital Board

Time Management of Class :

05 min for taking attendance 10 min for revision of previous class 130 min for the lecture delivery 05 min for doubts session

Assignment / Questions:
(Note: Mention for each question the relevant Objectives and Outcomes Nos.1, 2, 3, 4 & 1, 3...)

Refer assignment – III & tutorial-III sheets

Signature of faculty

Department of Civil Engineering

LESSON PLAN (U-IV)

Lesson No: 01, 02 Duration of Lesson: 1hr 40 min

Lesson Title: Introduction to Contract Management, Definitions of terms used in contract management

Instructional / Lesson Objectives:

- To make students understand about the contract management and contract document.
- To familiarize students about the project estimation and bidding process.
- To understand students about the classification of contract and construction planning techniques.
- To provide information on procurement process and planning of men, material, machinery and finance.

Teaching AIDS :PPTs, Digital Board

Time Management of Class :

05 min for taking attendance 10 min for revision of previous class 80 min for the lecture delivery 05 min for doubts session

Assignment / Questions:
(Note: Mention for each question the relevant Objectives and Outcomes Nos.1, 2, 3, 4 & 1, 3...)

Refer assignment – IV& tutorial-IV sheets

Signature of faculty

Department of Civil Engineering

LESSON PLAN (U-IV)

Lesson No: 03, 04 Duration of Lesson: 2hr 30 min

Lesson Title: Project estimation, methods of project estimation, Contract document (documents enclosed to contract)

Instructional / Lesson Objectives:

- To make students understand about the contract management and contract document.
- To familiarize students about the project estimation and bidding process.
- To understand students about the classification of contract and construction planning techniques.
- To provide information on procurement process and planning of men, material, machinery and finance.

Teaching AIDS :PPTs, Digital Board

Time Management of Class :

05 min for taking attendance 10 min for revision of previous class 130 min for the lecture delivery 05 min for doubts session

Assignment / Questions:
(Note: Mention for each question the relevant Objectives and Outcomes Nos.1, 2, 3, 4 & 1, 3...)

Refer assignment – IV & tutorial-IV sheets

Signature of faculty

Department of Civil Engineering

LESSON PLAN (U-IV)

Lesson No: 05, 06 Duration of Lesson: 1hr 40 min

Lesson Title: Classification of Contracts

Instructional / Lesson Objectives:

- To make students understand about the contract management and contract document.
- To familiarize students about the project estimation and bidding process.
- To understand students about the classification of contract and construction planning techniques.
- To provide information on procurement process and planning of men, material, machinery and finance.

Teaching AIDS :PPTs, Digital Board

Time Management of Class :

05 min for taking attendance 10 min for revision of previous class 80 min for the lecture delivery 05 min for doubts session

Assignment / Questions:
(Note: Mention for each question the relevant Objectives and Outcomes Nos.1, 2, 3, 4 & 1, 3...)

Refer assignment – IV & tutorial-IV sheets

Signature of faculty

Department of Civil Engineering

LESSON PLAN (U-IV)

Lesson No: 07, 08 Duration of Lesson: 2hr 30 min

Lesson Title: Bidding process, Procurement process (Steps involved)

Instructional / Lesson Objectives:

- To make students understand about the contract management and contract document.
- To familiarize students about the project estimation and bidding process.
- To understand students about the classification of contract and construction planning techniques.
- To provide information on procurement process and planning of men, material, machinery and finance.

Teaching AIDS :PPTs, Digital Board

Time Management of Class :

05 min for taking attendance 10 min for revision of previous class 130 min for the lecture delivery 05 min for doubts session

Assignment / Questions:
(Note: Mention for each question the relevant Objectives and Outcomes Nos.1, 2, 3, 4 & 1, 3...)

Refer assignment – IV & tutorial-IV sheets

Signature of faculty

Department of Civil Engineering

LESSON PLAN (U-IV)

Lesson No: 09, 10 Duration of Lesson: 1hr 40 min

Lesson Title: Construction planning and its types

Instructional / Lesson Objectives:

- To make students understand about the contract management and contract document.
- To familiarize students about the project estimation and bidding process.
- To understand students about the classification of contract and construction planning techniques.
- To provide information on procurement process and planning of men, material, machinery and finance.

Teaching AIDS :PPTs, Digital Board

Time Management of Class :

05 min for taking attendance 10 min for revision of previous class 80 min for the lecture delivery 05 min for doubts session

Assignment / Questions:
(Note: Mention for each question the relevant Objectives and Outcomes Nos.1, 2, 3, 4 & 1, 3...)

Refer assignment – IV & tutorial-IV sheets

Signature of faculty

Department of Civil Engineering

LESSON PLAN (U-IV)

Lesson No: 11, 12 Duration of Lesson: 2hr 30 min

Lesson Title: Project planning techniques, planning for men, material, finance, and machinery at construction site

Instructional / Lesson Objectives:

- To make students understand about the contract management and contract document.
- To familiarize students about the project estimation and bidding process.
- To understand students about the classification of contract and construction planning techniques.
- To provide information on procurement process and planning of men, material, machinery and finance.

Teaching AIDS :PPTs, Digital Board

Time Management of Class :

05 min for taking attendance 10 min for revision of previous class 130 min for the lecture delivery 05 min for doubts session

Assignment / Questions:
(Note: Mention for each question the relevant Objectives and Outcomes Nos.1, 2, 3, 4 & 1, 3...)

Refer assignment – IV & tutorial-IV sheets

Signature of faculty

Department of Civil Engineering

LESSON PLAN (U-V)

Lesson No: 01, 02 Duration of Lesson: 1hr 40 min

Lesson Title: Project Scheduling (Introduction), Introduction to PERT & CPM, Their difference

Instructional / Lesson Objectives:

- To make students understand about the project scheduling using PERT & CPM network techniques.
- To familiarize students about the Resource leveling and allocation and dispute resolution.
- To understand students about the construction claims, sources of claims and its management.
- To provide information on project closure by contract and construction closure.

Teaching AIDS :PPTs, Digital Board

Time Management of Class :

05 min for taking attendance 10 min for revision of previous class 80 min for the lecture delivery 05 min for doubts session

Assignment / Questions:
(Note: Mention for each question the relevant Objectives and Outcomes Nos.1, 2, 3, 4 & 1, 3...)

Refer assignment – V& tutorial-V sheets

Signature of faculty

Department of Civil Engineering

LESSON PLAN (U-V)

Lesson No: 03, 04, and 05 Duration of Lesson: 3hr 20 min

Lesson Title: Numerical problems on PERT & CPM Network technique, Resource leveling and its management

Instructional / Lesson Objectives:

- To make students understand about the project scheduling using PERT & CPM network techniques.
- To familiarize students about the Resource leveling and allocation and dispute resolution.
- To understand students about the construction claims, sources of claims and its management.
- To provide information on project closure by contract and construction closure.

Teaching AIDS :PPTs, Digital Board

Time Management of Class :

10 min for taking attendance 15 min for revision of previous class 160 min for the lecture delivery 15 min for doubts session

Assignment / Questions:
(Note: Mention for each question the relevant Objectives and Outcomes Nos.1, 2, 3, 4 & 1, 3...)

Refer assignment – V & tutorial-V sheets

Signature of faculty

Department of Civil Engineering

LESSON PLAN (U-V)

Lesson No: 06, 07 Duration of Lesson: 1hr 40 min

Lesson Title: Construction claims, sources of claim, Claim management

Instructional / Lesson Objectives:

- To make students understand about the project scheduling using PERT & CPM network techniques.
- To familiarize students about the Resource leveling and allocation and dispute resolution.
- To understand students about the construction claims, sources of claims and its management.
- To provide information on project closure by contract and construction closure.

Teaching AIDS :PPTs, Digital Board

Time Management of Class :

05 min for taking attendance 05 min for revision of previous class 80 min for the lecture delivery 10 min for doubts session

Assignment / Questions:
(Note: Mention for each question the relevant Objectives and Outcomes Nos.1, 2, 3, 4 & 1, 3...)

Refer assignment – V & tutorial-V sheets

Signature of faculty

Department of Civil Engineering

LESSON PLAN (U-V)

Lesson No: 08, 09 Duration of Lesson: 1hr 40 min

Lesson Title: Disputes and dispute resolution methods, Arbitration process

Instructional / Lesson Objectives:

- To make students understand about the project scheduling using PERT & CPM network techniques.
- To familiarize students about the Resource leveling and allocation and dispute resolution.
- To understand students about the construction claims, sources of claims and its management.
- To provide information on project closure by contract and construction closure.

Teaching AIDS :PPTs, Digital Board

Time Management of Class :

05 min for taking attendance 05 min for revision of previous class 80 min for the lecture delivery 10 min for doubts session

Assignment / Questions:
(Note: Mention for each question the relevant Objectives and Outcomes Nos.1, 2, 3, 4 & 1, 3...)

Refer assignment – V & tutorial-V sheets

Signature of faculty

Department of Civil Engineering

LESSON PLAN (U-V)

Lesson No: 10, 11 Duration of Lesson: 1hr 40 min

Lesson Title: Project Closure- Construction closure, Contract closure, and Documentation

Instructional / Lesson Objectives:

- To make students understand about the project scheduling using PERT & CPM network techniques.
- To familiarize students about the Resource leveling and allocation and dispute resolution.
- To understand students about the construction claims, sources of claims and its management.
- To provide information on project closure by contract and construction closure.

Teaching AIDS :PPTs, Digital Board

Time Management of Class :

05 min for taking attendance 05 min for revision of previous class 80 min for the lecture delivery 10 min for doubts session

Assignment / Questions:
(Note: Mention for each question the relevant Objectives and Outcomes Nos.1, 2, 3, 4 & 1, 3...)

Refer assignment – V & tutorial-V sheets

Signature of faculty

Department of Civil Engineering

LESSON PLAN (U-V)

Lesson No: 12, 13 Duration of Lesson: 2hr 30 min

Lesson Title: Practice on CPM & PERT Network Numerical Problems, Revision for II Mid examination

Instructional / Lesson Objectives:

- To make students understand about the project scheduling using PERT & CPM network techniques.
- To familiarize students about the Resource leveling and allocation and dispute resolution.
- To understand students about the construction claims, sources of claims and its management.
- To provide information on project closure by contract and construction closure.

Teaching AIDS :PPTs, Digital Board

Time Management of Class :

05 min for taking attendance 05 min for revision of previous class 130 min for the lecture delivery 10 min for doubts session

Assignment / Questions:
(Note: Mention for each question the relevant Objectives and Outcomes Nos.1, 2, 3, 4 & 1, 3...)

Refer assignment – V & tutorial-V sheets

Signature of faculty

Department of Civil Engineering

LESSON PLAN (U-V)

Lesson No: 14, 15 Duration of Lesson: 1hr 40 min

Lesson Title: Revision of overall syllabus, Old Question papers discussions

Instructional / Lesson Objectives:

- To make students understand about the project scheduling using PERT & CPM network techniques.
- To familiarize students about the Resource leveling and allocation and dispute resolution.
- To understand students about the construction claims, sources of claims and its management.
- To provide information on project closure by contract and construction closure.

Teaching AIDS :PPTs, Digital Board

Time Management of Class :

05 min for taking attendance 05 min for revision of previous class 80 min for the lecture delivery 10 min for doubts session

Assignment / Questions:
(Note: Mention for each question the relevant Objectives and Outcomes Nos.1, 2, 3, 4 & 1, 3...)

Refer assignment – V & tutorial-V sheets

Signature of faculty

Department of Civil Engineering

ASSIGNMENT SHEET – 1

This Assignment corresponds to Unit No. 1

Question No.	Question	Objective No.	Outcome No.
1	Explain in detail about construction activities and codes and regulations.	1	1
2	Demonstrate the construction process and scheduling in detail.	1	1
3	Explain in detail about construction records and documents.	1	1
4	Illustrate the quality and safety in construction. Write about the formwork.	1	1
5	Explain about earthwork and piling in construction.	1	1

Signature of HOD

Date:

Signature of faculty

Date:

Department of Civil Engineering

ASSIGNMENT SHEET – 2

This Assignment corresponds to Unit No. 2

Question No.	Question	Objective No.	Outcome No.
1	Explain about excavator with a neat sketch. And write their types & uses.	2	2
2	Explain about scrapper with a neat sketch. And write their types & uses.	2	2
3	Explain about rollers with a neat sketch. And write their types & uses.	2	2
4	How can you explain the concrete equipment used in the construction	2	2

Signature of HOD

Date:

Signature of faculty

Date:

Department of Civil Engineering

ASSIGNMENT SHEET– 3

This Assignment corresponds to Unit No. 3

Question No.	Question	Objective No.	Outcome No.
1	Differentiate between quality assurance and quality control. And explain about quality assurance and safety.	3	3
2	Explain in detail about ISO 9000 quality systems.	3	3
3	Explain about the principles on safety and personnel safety.	3	3
4	Write the advantages and disadvantages of Green Building.	3	3
5	Explain the personnel safety precautions in construction industry.	3	3

Signature of HOD

Date:

Signature of faculty

Date:

Department of Civil Engineering

ASSIGNMENT SHEET– 4

This Assignment corresponds to Unit No. 4

Question No.	Question	Objective No.	Outcome No.
1	Outline about planning of man power, material, machinery, and finance.	4	4
2	Explain about contract documents.	4	4
3	Write the classification of contracts and explain briefly.	4	4
4	Illustrate the project planning techniques.	4	4
5	Demonstrate the stages of contract management.	4	4

Signature of HOD

Date:

Signature of faculty

Date:

Department of Civil Engineering

ASSIGNMENT SHEET – 5

This Assignment corresponds to Unit No. 5

<table>
<tr><th>Question No.</th><th>Question</th><th>Objective No.</th><th>Outcome No.</th></tr>
<tr><td>1</td><td>Write a short note on i) Dispute resolution ii) Arbitration</td><td>5</td><td>5</td></tr>
<tr><td>2</td><td>Illustrate briefly about the steps involved in project closure.</td><td>5</td><td>5</td></tr>
<tr><td>3</td><td>A project consists of 9 activities their respective duration is given below. Construct the CPM network and find the critical path.
<table>
<tr><td>Activity</td><td>1-2</td><td>1-3</td><td>2-4</td><td>2-5</td><td>3-5</td><td>4-5</td><td>4-6</td><td>5-6</td><td>6-7</td></tr>
<tr><td>Duration in days</td><td>5</td><td>7</td><td>10</td><td>9</td><td>6</td><td>4</td><td>8</td><td>12</td><td>8</td></tr>
</table></td><td>5</td><td>5</td></tr>
<tr><td>4</td><td>Demonstrate the difference between CPM and PERT.</td><td>5</td><td>5</td></tr>
<tr><td>5</td><td>A project consists of 11 activities their respective duration is given below. Construct the CPM network and find the EST, EFT, LST, LFT, TF, FF and critical path.
<table>
<tr><td>Activity</td><td>1-2</td><td>1-3</td><td>1-4</td><td>2-4</td><td>2-6</td><td>3-4</td><td>3-5</td><td>4-6</td><td>4-7</td><td>5-7</td><td>6-7</td></tr>
<tr><td>Duration in days</td><td>6</td><td>4</td><td>9</td><td>2</td><td>5</td><td>7</td><td>8</td><td>3</td><td>10</td><td>4</td><td>8</td></tr>
</table></td><td>5</td><td>5</td></tr>
</table>

Signature of HOD

Date:

Signature of faculty

Date:

Department of Civil Engineering

TUTORIAL SHEET– 1

This tutorial corresponds to Unit No. 1 (Objective Nos.: 1, Outcome Nos.: 1)

Q1. The first stage of a construction is

A) Preparation of estimation B) Survey of the site
C) Initiation of proposal D) Preparation of tender

Q2. The Overall in-charge of an organization at the site responsible for the execution of the works, is

A) Executive Engineer B) Engineer
C) Junior Engineer D) Assistant Engineer

Q3. Piles are used for

A) To resist uplift forces such as: basement slab below the water table C) To enhance load-bearing capacity of soil
B) To transfer the loads through water to the underlying soil D) All the above

Q4. Fabrication is not suitable for

A) Welding C) Bolting
B) Carpentry work D) Riveting

Q5. The three factors that determine the effective Construction Process are

A) The nature of the construction activities involved carried out B) The place where construction work is to be
C) The time available for construction work D) All the above

Signature of HOD Signature of faculty

Date: Date:

Department of Civil Engineering

TUTORIAL SHEET – 2

This tutorial corresponds to Unit No. 2 (Objective Nos.: 2, Outcome Nos.: 2)

Q1. Boom is containing which equipment

A) Back hoe B) Roller
C) Dozer D) None of these

Q2. Dozer is an attachment of

A) Scrapper B) Face shovel
C) Tractor D) Grader

Q3. Which of the construction equipment which is not suitable for compaction

A) Sheep foot roller B) Excavator
C) Rubber type roller D) Tandem roller

Q4. Which type of excavator is used for digging at or below the operating level

A) Drag line B) Skimmer
C) Grader D) Power shovel

Q5. For moving large objects which one of construction vehicle is suitable

A) Roller B) clamshell
C) Excavator D) Scrapper

Signature of HOD

Date:

Signature of faculty

Date:

Department of Civil Engineering

TUTORIAL SHEET – 3

This tutorial corresponds to Unit No. 3 (Objective Nos.: 3, Outcome Nos.: 3)

Q1. What does QA and QC stands for

A) Quality adjustment and Quality queuing B) Quality assurance and Quality control
C) Quality adjustment and Quality control D) Quality adjustment and Quality completion

Q2. Which of the following is an example of?

A) Validation B) Software testing
C) Verification D) Documentation

Q3. What exactly is the certification processing accordance with ISO 9001?

A) Preliminary audit (optional) B) Certification audit
C) Conferral of certificate D) All of the above

Q4. Which of the following option is correct regarding QA and AC?

A) QC is an integral part of QA B) QA is an integral part of QC
C) QA and QC are independent to Each other D) QC may or may not depend on QA

Q5. Where the nodal point for national measurement system is located?

A) Bangalore B) Patna
C) Bombay D) New Delhi

Signature of HOD Signature of faculty

Date: Date:

Department of Civil Engineering
TUTORIAL SHEET– 4

This tutorial corresponds to Unit No. 4 (Objective Nos.: 3, Outcome Nos.: 3)

Q1.In a standardized contract

A) The individual has no choice but to accept and sign on the dotted line.
B) The individual must be protected in contract.
C) The agreement is without consideration.
D) None of the above

Q2. The correct sequence in the formation of a contract is

A) Offer, acceptance, agreement, consideration. B) Agreement, consideration, offer, acceptance.
C) Offer, Consideration, acceptance, agreement. D) Offer,acceptance, consideration, agreement

Q3. Which of the following statement is not correct?

A) Minor's agreement is void. B) Wagering agreement is void
C) Agreement caused by mutual mistake is void. D) Contract without consideration is void.

Q4. A contract caused by one of the parties to it being under a mistake as to matter of fact is

A) Void B) Valid
C) Voidable at the option of either party D) Voidable at the option of the party who under mistake

Q5. A voluntary arrangement between two or more parties that is enforceable by law as a binding legal agreement is known as

A) Job B) Loan
C) Contract D) Mutual fund

Signature of HOD

Signature of faculty

Date:

Date:

Department of Civil Engineering

TUTORIAL SHEET– 5

This tutorial corresponds to Unit No. 5 (Objective Nos.: 5, Outcome Nos.: 5)

Q1. What is PERT analysis based on?

A) Optimistic time B) Pessimistic time
C) Most likely time D) All of the above

Q2. Which of the options is not a notable challenge while scheduling a project?

A) Deadlines exist B) Independent activities
C) Too many workers may be required D) Costly delay

Q3. What is the particular task performance in CPM known as

A) Dummy B) Event
C) Activity D) Contract

Q4. What is the earliest start time rule?

A) It compares the activity's starting time for an activity successor
B) It compares the activity's end time for an activity predecessor
C) It directs when a project can start
D) It regulates when a project must begin

Q5. What is a critical path?

A) It is a path that operates from the starting node to the end node.
B) It is a mixture of all the paths
C) It is the longest path
D) It is the shortest path

Signature of HOD Signature of faculty

Date: Date:

Department of Civil Engineering

EVALUATION STRATEGY

Target (s)

a. Percentage of Pass : 95%

Assessment Method (s) (Maximum Marks for evaluation are defined in the Academic Regulations)

a. Daily Attendance
b. Assignments
c. Online Quiz (or) Seminars
d. Continuous Internal Assessment
e. Semester / End Examination

List out any new topic(s) or any innovation you would like to introduce in teaching the subjects in this semester

Case Study of any one existing application

Signature of HOD

Date:

Signature of faculty

Date:

Department of Civil Engineering

COURSE COMPLETION STATUS

Actual Date of Completion & Remarks if any

Units	Remarks	Objective No. Achieved	Outcome No. Achieved
Unit 1	completed on 05.12.2023	1	1
Unit 2	completed on 27.12.2023	2	2
Unit 3	completed on 23.01.2024	3	3
Unit 4	completed on 12.02.2024	4	4
Unit 5	completed on 03.04.2024	5	5

Signature of HOD

Date:

Signature of faculty

Date:

Department of Civil Engineering
Mappings

1. Course Objectives-Course Outcomes Relationship Matrix

(Indicate the relationships by mark "X")

Course-Outcomes / Course-Objectives	1	2	3	4	5
1	H		M		
2		H			
3			H		M
4		M		H	
5			L		H

2. Course Outcomes-Program Outcomes (POs) & PSOs Relationship Matrix

(Indicate the relationships by mark "X")

P-Outcomes / C-Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO 1	PSO 2
1		√	√	√	√	√		√	√	√	√	√	H	
2				√		√		√	√		√	√		H
3					√	√			√	√	√		M	M
4		√	√		√				√	√	√		M	
5		√	√	√	√			√	√		√	√		

Department of Civil Engineering

Rubric for Evaluation

Performance Criteria	Unsatisfactory	Developing	Satisfactory	Exemplary
	1	2	3	4
Research & Gather Information	Does not collect any information that relates to the topic	Collects very little information some relates to the topic	Collects some basic Information most relates to the topic	Collects a great deal of Information all relates to the topic
Fulfill team role's duty	Does not perform any duties of assigned team role.	Performs very little duties.	Performs nearly all duties.	Performs all duties of assigned team role.
Share Equally	Always relies on others to do the work.	Rarely does the assigned work - often needs reminding.	Usually does the assigned work - rarely needs reminding.	Always does the assigned work without having to be reminded
Listen to other team mates	Is always talking—never allows anyone else to speak.	Usually doing most of the talking-- rarely allows others to speak.	Listens, but sometimes talks too much.	Listens and speaks a fair amount.

ANURAG Engineering College

(An Autonomous Institution)

Ananthagiri (V&M), Suryapet (Dt), Telangana – 508206.

IV B.Tech II Semester I MID Examinations, Jan 2024

Branch: Common for MECH, EEE, ECE & CSE		**Max. Marks: 20**
Date: 12-01-2024 (AN)	**Subject : Project Management**	**Time: 90 Min.**

PART-A

Answer all the questions **5 X 1M=5 Marks**

Q.NO	**Question**	**Course Outcome**	**Bloom's Level**
1.	State the construction records.	CO1	L1
2.	Write a short note on construction scheduling.	CO1	L1
3.	Explain about the applications of excavator.	CO2	L2
4.	What are the equipment used in earthwork.	CO2	L2
5.	Define quality assurance.	CO3	L1

PART-B

Answer the following **3 X 5M=15 Marks**

Q.NO	**Question**	**Course Outcome**	**Bloom's Level**
6.	Define concrete. And explain about concreting process.	CO1	L1 & L3
	OR		
7.	Explain about fabrication & erection of steel structures.	CO1	L3
8.	Illustrate the handling equipment and explain briefly about any one of them with neat sketch.	CO2	L4
	OR		
9.	Illustrate about the scraper with neat sketch. And also write their applications.	CO2	L4
10.	Explain briefly about ISO 9000 quality systems.	CO3	L3
	OR		
11.	Differentiate between quality control and quality assurance.	CO3	L3

ANURAG Engineering College

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Ananthagiri (V&M), Suryapet (Dt), Telangana – 508206.

IV B.Tech II Semester II MID Examinations, April 2024

Branch: COMMON For EEE, MECH, ECE & CSE		**Max. Marks: 20**
Date: 10-04-2024 (FN)	**Subject : Project Management**	**Time: 90 Min.**

PART-A

Answer all the questions **5 X 1M=5 Marks**

Q.NO	**Question**	**Course Outcome**	**Bloom's Level**
1.	Write a note on personnel safety.	CO3	L2
2.	What is the process of project estimation?	CO4	L1
3.	Discuss about contract documents.	CO4	L2
4.	State the disadvantages of arbitration?	CO5	L1
5.	Describe about project closure.	CO5	L2

PART-B

Answer the following **3 X 5M=15 Marks**

<table>
<tr><th>Q.NO</th><th>Question</th><th>Course Outcome</th><th>Bloom's Level</th></tr>
<tr><td>6.</td><td>Explain the concept of green building and how do you compare green building with normal regular building.</td><td>CO3</td><td>L4</td></tr>
<tr><td colspan="4">OR</td></tr>
<tr><td>7.</td><td>Explain in detail about fire safety.</td><td>CO3</td><td>L3</td></tr>
<tr><td>8.</td><td>Write the classification of contracts and explain briefly.</td><td>CO4</td><td>L3</td></tr>
<tr><td colspan="4">OR</td></tr>
<tr><td>9.</td><td>Illustrate the project planning techniques.</td><td>CO4</td><td>L4</td></tr>
<tr><td>10.</td><td>A project consists of 9 activities their respective duration are given below. Construct the CPM network and find the critical path.
<table>
<tr><td>Activity</td><td>1-2</td><td>1-3</td><td>2-4</td><td>2-5</td><td>3-5</td><td>4-5</td><td>4-6</td><td>5-6</td><td>6-7</td></tr>
<tr><td>Duration in days</td><td>5</td><td>7</td><td>10</td><td>9</td><td>6</td><td>4</td><td>8</td><td>12</td><td>8</td></tr>
</table></td><td>CO5</td><td>L4</td></tr>
<tr><td colspan="4">OR</td></tr>
<tr><td>11.</td><td>Explain about dispute resolution methods.</td><td>CO5</td><td>L3</td></tr>
</table>

First Internal Examination Marks

Programme**: BTech** Year: **IV** Course: **Theory** **A.Y: 2023-24**

Course: **Project Management** Section: **CSE-A** Faculty Name: **G Narender**

S. No	Roll No	Assignment Marks (5)	Subjective Marks (20)	Total Marks (25)
1	20C11A0501	5	10	15
2	20C11A0502	5	18	23
3	20C11A0503	5	12	17
4	20C11A0504	5	20	25
5	20C11A0505	5	12	17
6	20C11A0506	5	13	18
7	20C11A0507	AB	AB	0
8	20C11A0508	5	12	17
9	20C11A0510	5	15	20
10	20C11A0511	5	10	15
11	20C11A0512	5	17	22
12	20C11A0513	5	19	24
13	20C11A0514	5	15	20
14	20C11A0515	5	18	23
15	20C11A0516	5	20	25
16	20C11A0517	5	17	22
17	20C11A0518	5	18	23
18	20C11A0519	5	15	20
19	20C11A0520	5	19	24
20	20C11A0521	5	20	25
21	20C11A0522	5	14	19
22	20C11A0523	5	17	22
23	20C11A0524	5	19	24
24	20C11A0525	4	12	16
25	20C11A0526	5	19	24
26	20C11A0527	5	18	23
27	20C11A0528	5	17	22
28	20C11A0529	4	16	20

29	20C11A0530	5	17	22
30	20C11A0531	5	12	17
31	20C11A0532	5	17	22
32	20C11A0533	5	19	24
33	20C11A0534	5	19	24
34	20C11A0535	5	9	14
35	20C11A0536	5	15	20
36	20C11A0538	5	13	18
37	20C11A0539	5	10	15
38	20C11A0540	5	10	15
39	20C11A0542	5	16	21
40	20C11A0543	5	13	18
41	20C11A0544	5	18	23
42	20C11A0545	5	18	23
43	20C11A0546	5	16	21
44	20C11A0547	5	13	18
45	20C11A0548	5	AB	5
46	20C11A0549	5	14	19
47	20C11A0550	5	16	21
48	20C11A0551	5	14	19
49	20C11A0552	5	16	21
50	20C11A0553	5	16	21
51	20C11A0554	5	15	20
52	20C11A0555	5	15	20
53	20C11A0557	5	18	23
54	20C11A0558	5	14	19
55	20C11A0559	5	10	15
56	20C11A0560	5	AB	5
57	20C11A0561	5	12	17
58	20C11A0562	5	16	21
59	20C11A0563	5	12	17
60	20C11A0564	5	15	20
61	20C11A0565	5	15	20

62	20C11A0566	5	15	20

No. of Absentees: 03

Total Strength: 62

Signature of Faculty: **Signature of HoD**

Second Internal Examination Marks

Programme**: BTech** Year: **IV** Course: **Theory** **A.Y: 2023-24**

Course: **Project Management** Section: **CSE-A** Faculty Name: **G Narender**

S. No	Roll No	Assignment Marks (5)	Subjective Marks (20)	Total Marks (25)
1	20C11A0501	5	14	19
2	20C11A0502	5	17	22
3	20C11A0503	5	12	17
4	20C11A0504	5	20	25
5	20C11A0505	5	19	24
6	20C11A0506	5	15	20
7	20C11A0507	AB	AB	0
8	20C11A0508	5	12	17
9	20C11A0510	5	12	17
10	20C11A0511	5	10	15
11	20C11A0512	5	12	17
12	20C11A0513	5	18	23
13	20C11A0514	5	18	23
14	20C11A0515	5	19	24
15	20C11A0516	5	19	24
16	20C11A0517	5	18	23
17	20C11A0518	5	11	16
18	20C11A0519	5	15	20
19	20C11A0520	5	20	25
20	20C11A0521	5	20	25
21	20C11A0522	5	12	17
22	20C11A0523	5	14	19
23	20C11A0524	5	18	23
24	20C11A0525	5	AB	5
25	20C11A0526	5	19	24
26	20C11A0527	5	20	25
27	20C11A0528	5	13	18
28	20C11A0529	5	17	22

29	20C11A0530	5	16	21
30	20C11A0531	5	13	18
31	20C11A0532	5	AB	5
32	20C11A0533	5	17	22
33	20C11A0534	5	20	25
34	20C11A0535	5	11	16
35	20C11A0536	5	17	22
36	20C11A0538	5	15	20
37	20C11A0539	5	11	16
38	20C11A0540	5	9	14
39	20C11A0542	5	14	19
40	20C11A0543	5	12	17
41	20C11A0544	5	15	20
42	20C11A0545	5	16	21
43	20C11A0546	5	10	15
44	20C11A0547	5	11	16
45	20C11A0548	5	17	22
46	20C11A0549	5	12	17
47	20C11A0550	5	17	22
48	20C11A0551	5	14	19
49	20C11A0552	5	14	19
50	20C11A0553	5	18	23
51	20C11A0554	5	19	24
52	20C11A0555	5	13	18
53	20C11A0557	5	18	23
54	20C11A0558	5	16	21
55	20C11A0559	5	9	14
56	20C11A0560	5	14	19
57	20C11A0561	5	13	18
58	20C11A0562	5	19	24
59	20C11A0563	5	12	17
60	20C11A0564	5	10	15
61	20C11A0565	5	15	20

62	**20C11A0566**	**5**	**19**	**24**

No. of Absentees: 03

Total Strength: 62

Signature of Faculty: **Signature of HoD**

First Internal Examination Marks

Programme**: BTech** Year: **IV** Course: **Theory** **A.Y: 2023-24**

Course: **Project Management** Section: **ECE-A** Faculty Name: **G Narender**

S. No	Roll No	Assignment Marks (5)	Subjective Marks (20)	Total Marks (25)
1	20C11A0402	5	15	20
2	20C11A0403	5	9	14
3	20C11A0404	5	10	15
4	20C11A0406	5	9	14
5	20C11A0407	5	16	21
6	20C11A0408	5	11	16
7	20C11A0409	5	9	14
8	20C11A0410	5	14	19
9	20C11A0411	5	10	15
10	20C11A0412	5	9	14
11	20C11A0413	5	15	20
12	20C11A0414	5	19	24
13	20C11A0416	5	13	18
14	20C11A0418	5	11	16
15	20C11A0419	5	16	21
16	20C11A0420	5	15	20
17	20C11A0421	5	18	23
18	20C11A0422	5	11	16
19	20C11A0423	5	9	14
20	20C11A0424	5	11	16
21	20C11A0426	5	11	16
22	20C11A0428	5	11	16
23	20C11A0429	5	16	21
24	20C11A0430	5	18	23
25	20C11A0431	5	AB	5
26	20C11A0432	5	18	23
27	20C11A0433	5	17	22
28	20C11A0434	5	11	16

29	20C11A0435	5	9	14
30	20C11A0436	5	17	22
31	20C11A0437	5	13	18
32	20C11A0438	5	12	17
33	20C11A0439	5	5	10
34	20C11A0440	5	9	14
35	20C11A0441	4	15	19
36	20C11A0443	5	15	20
37	20C11A0444	4	7	11
38	20C11A0445	5	18	23
39	20C11A0446	4	10	14
40	20C11A0447	5	11	16
41	20C11A0448	5	9	14
42	20C11A0449	5	9	14
43	20C11A0450	5	15	20

No. of Absentees: 01

Total Strength: 43

Signature of Faculty: **Signature of HoD**

Second Internal Examination Marks

Programme**: BTech** Year: **IV** Course: **Theory** **A.Y: 2023-24**

Course: **Project Management** Section: **ECE-A** Faculty Name: **G Narender**

S. No	Roll No	Assignment Marks (5)	Subjective Marks (20)	Total Marks (25)
1	20C11A0402	5	13	18
2	20C11A0403	5	12	17
3	20C11A0404	5	17	22
4	20C11A0406	5	12	17
5	20C11A0407	5	16	21
6	20C11A0408	4	14	18
7	20C11A0409	5	15	20
8	20C11A0410	5	15	20
9	20C11A0411	5	9	14
10	20C11A0412	5	8	13
11	20C11A0413	5	16	21
12	20C11A0414	5	19	24
13	20C11A0416	4	12	16
14	20C11A0418	5	12	17
15	20C11A0419	5	11	16
16	20C11A0420	5	14	19
17	20C11A0421	5	18	23
18	20C11A0422	5	12	17
19	20C11A0423	5	AB	5
20	20C11A0424	5	17	22
21	20C11A0426	5	9	14
22	20C11A0428	5	11	16
23	20C11A0429	5	18	23
24	20C11A0430	5	15	20
25	20C11A0431	5	9	14
26	20C11A0432	5	19	24
27	20C11A0433	5	12	17
28	20C11A0434	5	9	14

29	20C11A0435	5	10	15
30	20C11A0436	5	14	19
31	20C11A0437	5	9	14
32	20C11A0438	5	13	18
33	20C11A0439	5	5	10
34	20C11A0440	5	3	8
35	20C11A0441	5	14	19
36	20C11A0443	5	12	17
37	20C11A0444	5	7	12
38	20C11A0445	5	17	22
39	20C11A0446	5	10	15
40	20C11A0447	5	10	15
41	20C11A0448	5	9	14
42	20C11A0449	5	7	12
43	20C11A0450	5	15	20

No. of Absentees: 01

Total Strength: 43

Signature of Faculty: **Signature of HoD**

First Internal Examination Marks

Programme**: BTech** Year: **IV** Course: **Theory** **A.Y: 2023-24**

Course: **Project Management** Section: **ECE-B** Faculty Name: **G Narender**

S. No	Roll No	Assignment Marks (5)	Subjective Marks (20)	Total Marks (25)
1	20C11A0451	5	9	14
2	20C11A0452	5	19	24
3	20C11A0453	5	17	22
4	20C11A0455	5	15	20
5	20C11A0456	5	19	24
6	20C11A0457	5	11	16
7	20C11A0458	5	20	25
8	20C11A0459	5	15	20
9	20C11A0460	5	16	21
10	20C11A0461	5	16	21
11	20C11A0462	5	18	23
12	20C11A0463	5	15	20
13	20C11A0464	5	14	19
14	20C11A0465	5	6	11
15	20C11A0466	5	9	14
16	20C11A0467	5	15	20
17	20C11A0468	5	17	22
18	20C11A0469	5	15	20
19	20C11A0470	5	9	14
20	20C11A0471	5	6	11
21	20C11A0472	5	9	14
22	20C11A0474	5	8	13
23	20C11A0475	5	16	21
24	20C11A0477	AB	AB	0
25	20C11A0478	5	17	22
26	20C11A0479	5	14	19
27	20C11A0480	5	11	16
28	21C15A0401	5	18	23

29	**21C15A0402**	**5**	**12**	**17**
30	**21C15A0403**	**5**	**15**	**20**
31	**21C15A0404**	**5**	**18**	**23**
32	**21C15A0405**	**5**	**17**	**22**
33	**21C15A0406**	**5**	**17**	**22**
34	**21C15A0407**	**5**	**16**	**21**
35	**21C15A0408**	**5**	**8**	**13**
36	**21C15A0409**	**5**	**16**	**21**
37	**21C15A0410**	**5**	**10**	**15**
38	**21C15A0412**	**5**	**10**	**15**
39	**21C15A0413**	**5**	**14**	**19**
40	**21C15A0414**	**5**	**10**	**15**
41	**21C15A0415**	**5**	**12**	**17**
42	**16C11A0463**	**5**	**18**	**23**

No. of Absentees: 01

Total Strength: 42

Signature of Faculty: **Signature of HoD**

Second Internal Examination Marks

Programme**: BTech** Year: **IV** Course: **Theory** **A.Y: 2023-24**

Course: **Project Management** Section: **ECE-B** Faculty Name: **G Narender**

S. No	Roll No	Assignment Marks (5)	Subjective Marks (20)	Total Marks (25)
1	20C11A0451	5	12	17
2	20C11A0452	5	18	23
3	20C11A0453	5	18	23
4	20C11A0455	5	17	22
5	20C11A0456	5	20	25
6	20C11A0457	5	11	16
7	20C11A0458	5	19	24
8	20C11A0459	5	17	22
9	20C11A0460	5	18	23
10	20C11A0461	5	AB	5
11	20C11A0462	5	17	22
12	20C11A0463	5	17	22
13	20C11A0464	5	10	15
14	20C11A0465	5	7	12
15	20C11A0466	5	11	16
16	20C11A0467	5	15	20
17	20C11A0468	5	18	23
18	20C11A0469	5	17	22
19	20C11A0470	5	11	16
20	20C11A0471	AB	5	5
21	20C11A0472	5	9	14
22	20C11A0474	5	9	14
23	20C11A0475	5	14	19
24	20C11A0477	AB	AB	0
25	20C11A0478	5	16	21
26	20C11A0479	5	14	19
27	20C11A0480	5	13	18
28	21C15A0401	5	14	19

29	**21C15A0402**	**5**	**12**	**17**
30	**21C15A0403**	**5**	**15**	**20**
31	**21C15A0404**	**5**	**16**	**21**
32	**21C15A0405**	**5**	**14**	**19**
33	**21C15A0406**	**5**	**15**	**20**
34	**21C15A0407**	**5**	**18**	**23**
35	**21C15A0408**	**5**	**9**	**14**
36	**21C15A0409**	**5**	**15**	**20**
37	**21C15A0410**	**5**	**15**	**20**
38	**21C15A0412**	**5**	**16**	**21**
39	**21C15A0413**	**5**	**16**	**21**
40	**21C15A0414**	**5**	**14**	**19**
41	**21C15A0415**	**5**	**17**	**22**
42	**16C11A0463**	**5**	**19**	**24**

No. of Absentees: 02

Total Strength: 42

Signature of Faculty: **Signature of HoD**

ANURAG ENGINEERING COLLEGE

(An Autonomous Institution)

(Approved by AICTE, New Delhi, Affiliated to JNTUH, Hyderabad, Accredited by NAAC with A+ Grade)

Ananthagiri (V & M), Kodad, Suryapet (Dist), Telangana.

Program		
B.Tech. ✓	M.Tech.	M.B.A.

YEAR	SEMESTER	MID EXAMINATION
IV	I	I

HALL TICKET NO.									
2	1	C	1	5	A	0	2	0	5

Regulation : R-18 | Branch or Specialization: EEE

Signature of Student: Ch. Jahnavi

Course: Project Management

Signature of invigilator with date:

Signature of the Evaluator:

Q.No. and Marks Awarded										
1	2	3	4	5	6	7	8	9	10	11
1	1	1	1	1	5					5

Maximum Marks: 20 | Marks Obtained: 20

(Start Writing From Here)

part - A

1. **Construction activities:**

The construction activities are the activities which are done in the part of construction. The construction activities are used to know the type of construction and how much time it required to complete the construction and cost of the construction.

2. **construction process:**

The construction process includes the sequence of doing construction activities. The construction process is used to analyze the design and considerations of construction.

3. **Mechanized construction:**

The construction in which we decrease the labour and increases the usage of large machines is known as Mechanized construction.

4. **Handling equipment:**

The Handling Equipment used in construction are:

i) Cranes.

ii) Draglines

5 quality control:-

The quality control (QC) is used to detect an error [in the occurrence of an error] when it occurs.

part-B

6. Construction Methods:-

The MMC (Modren Methods of construction) are now-mostly used in now a-days to decrease the time of construction and for some new designs. There are five types of construction methods. They are:-

i) Modular constructions / 3D volumetric units.
ii) Flat slab constructions.
iii) Twin wall construction.
iv) Hybrid construction.
v) 3D printing.

i) Modular constructions:-

These are the constructions which are done at off-site by parts. after completion of construction we will transport the parts to the on-site and they get joined there. This types of construction is known as Modular construction

ii) Flat slab constructions:-

In this type of construction we construct the flat slabs with the help of columns. There is no need beams in this construction. The load of the slab will be on the columns. It will increase the speed of the construction.

iii) Twin wall construction:-

first we will have some 2D Thin walls which are joined according to the required designed. The space between the wall is filled by the concrete the the wall be ready after the concrete dried. This can also be done by the precasting walls.

iv) Hybrid construction:-

of construction is done. in long buildings. which will take less time to complete the construction.

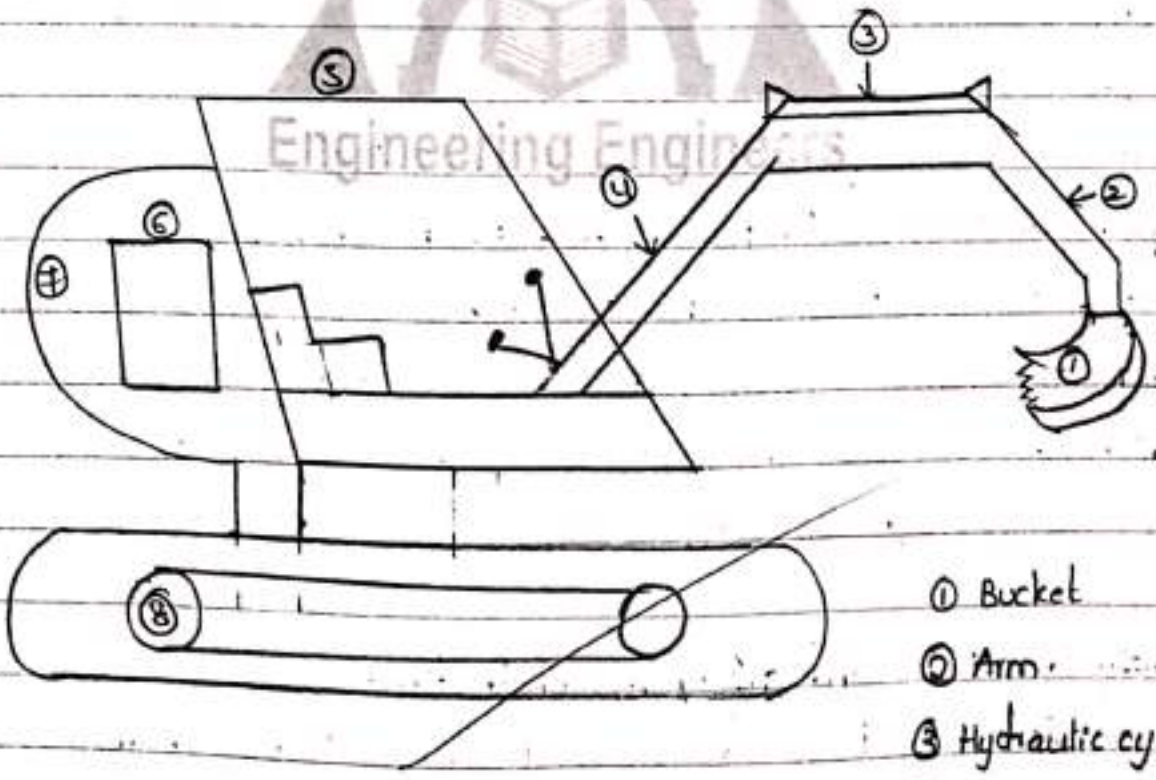
v) 3D printing:

This method is the new fastly implementing method. In this we use a large machine. we already store the design in the machince. when we the machine is on it will print the exact design with concrete. It requires less labours but some skilled persons.

---

8. Excavator:

* In a construction site the must needed machine is the excavator. It is used to do the earth work. and helps to remove the extra soil.
* The excavator is a machine which is used to remove extra soil and rocks and other unwanted materials.



① Bucket
② Arm
③ Hydraulic cylinder
④ Boom
⑤ Cab

① Bucket :- The bucket is used to Excavate the soil from the Earth.

② Arm :- The Arm is the support of the Bucket

③ Hydraulic cylinder :- The Hydraulic cylinder is used to control the movements of Arm and Bucket.

④ Boom :- Boom is the main connecting part.

⑤ cab :- cab is the main part in the machine from where the machine can operated by the skilled person.

⑥ Engine :- Engine is the heaviest part becaus to give balance to the machine and for the operation.

⑦ counter weight :- It is a extra added weight to the machine to balance it.

⑧ Track :- It is a moving part. and it moves the machines.

There are some other connecting parts for the machine. They are

① Bucket

② Augger

③ clamp

④ coupler

⑤ Drill.

Augger :- It is used to Bore a hole to the ground.

Drill :- It is used to Break the Big stones.

clamp :- It is used to remove heavy materials from the required place.

coupler :- It is used to change the connections without the help of crew. It is used for fast operation.

---

11. quality assurance and safety in construction :-

* The quality assurance is known as the used to prevent the before getting an error.

* The quality assurance and safety are the main objectives in construction.

* The quality is the main part to achieve Because in there any problem held

* Sometimes we can also have some accidents at the site. Because of this hazard there will be some insurance, medical support and other are the indirect cost loss. So it directly cost loss in the construction from some other aspects.

Quality concern of building construction:-

* If their is any quality issuse are design considerations they should be done in planning and designing stage. Because at the starting only we can change it & that will helpful to increase the quality.
* At preliminaries only we can understand the material specifications and quality of the material so there is a chance to change them with no damage.
* To attain the quality for long projects it is somewhat impossible thing to get maintain.

Safety concern of building construction:-

* We have to know the safety measurements of the building which will helps us to keep safe.
* It is very hazardous thing to work on a construction site. which will get more loss if any accident held.
* So we have to implement some safety measurements at the planing and designing stage. It will keep good safety to the labour.

causes of accidents in construction:-

i) struck by moving vehicle
ii) Transport accidents.
iii) struck by moving / falling objects.
iv) Trapped under a falling object.
v) Exposed to Environment.
vi) By falling from heights.

PM - Assignment

T. Arun Kumar

21015A0302

Mechanical engineering.

1 Explain in detail about construction records & documents

1 A) construction Records :- Record to be maintained at constra sites play important role in construction activities if any additional work has been carried out & its claimed during bil maintinance of records also helps during audit of construction Project at any point of time. These documents help to defend any claims such as Liquified Damages or false claims.

Records at construction site :-

The following are the various records that need to be maintaine at construction site.

- Drawings :- first & foremost, import records to be maintained or Site are the working drawing approved by the clients & design engineer. There is diff. kept of drawings rea for construction. Architectural drawing, Schutral drawing finishing etc.
- Contact Agreement :- contrate agreement documents including Set of drawings, including imendments, a copy of approval of municip corporation or lobag development activities need to be maintain at construction site.
- work order book :- All the orders given by clients to contracto need to maintained with Serial numbers, Signatures & dates.
- work Diary :- work diary of a construction project should indicate contract agreement number, name of work of contract

Cement Register :- This record is maintained with details receipts, daily consumptions & remaining balance of cement at site.

Register for Approval of Samples :- This records provides details of all the samples for construction materials has been approved or rejected by client.

Records of changes, Deviation orders & Amendments :- many a times during the construction projects, there are deviations or changes or emendments to the contract projects, these are deviations or changes or emendments to the contract documents & work activities from time to time during construction project as required by client.

measurment Books :- The measurment book is a record for all time construction activities carried out & approved by the client.

Labour Attendance :- Generally for labour contractor payments daily or every shift attendance record is kept.

Periodic Bin record :- Bills or Book till date from the previous bill & book work checked by engineer-in-charge put up for payment.

Illustrate the quality & safety in construction, write about the farmwork?

2

Quality :- Quality in construction industry can be defined as attainment of acceptable levels of performance from construction activities.

objective of quality in construction

- satisfaction of contractor specifications.
- completion of project within time.
- Arciding. Dispertes & claints.
- Performance based on purpose.

Quality Assurance in construction:

Quality assurance are certain schemes that is implemented construction in order to maintain the standard on the quality of the work in a consistant manner.

the companies generaly will have a quality assurance that will specify various checks at diff. levels.

Quality control in construction.

- Quality control is undergone by the team ac engineer special trained teams.
- Quality control focuses on: selting & practing specific standard for construction

Quality of conformpace:- It is defened to the degree to which the constructed facility conformed the design & speci

Safety:- construction sites are dangerous place to work. follow the simple construction site. Safety rules to keep yourself & others safe & prevent accidents.

Wear your PPE at all times:- when you enter the site, make sure you have the PPE you need. PPE is important, it's you last time of defense should you come, into contact with or hazard on site.

Do not put yourself or others on risk:- Especiamy on construction site where one wrong move could put you in harms way. make sure you regain safety aware throughout you shift.

Use the right eavipment:- using the correct tool for the work will get it done avicker, & most importancy, safety visuamy check eavipment is the good condition & safe to use before you start.

6

3 Explain about rollers with a neat Sketch find write the types of uses?

Compaction eavipment (Rollers)

The Season for compaction is to improve Soil properties t

- Reduce or prevent Settlement.
- Increase Strength.
- Improved Bearing capacity
- control volume changes
- Lowed permeability.

Types of Rollers;-

The various types of rollers which are used for compactic

1. cylindrical Rollers:- This is a light Soller of iron, concret or Stone, driven by hand or bulocks. The Size varies, but i is ejeveraw about 1 meter in dia & about 1.5 meter long This type of eponed pressure generated by this type of Soller is about 7 kg/cm².

2. Sheeps foot Rollers:- This type of roller consists of a drum having many round or rectorgular shaped protrsion 'fect' on it.

3. Pneumatic tyred roller :-

this type of roller consists of a heavily loaded wagon, with several rows of a six closely spaced tires.

Tire pressure may be up to about 7kg/cm²; the coverage over is about - 80%.

The max density can be achieved by 8 passes of roller. The optimum speed of roller is b/w 6 to 24 Km/h

4. Smooth wheeled roller :-

this type of roller consists of a large steel drum in front & one or two wheeled roller drum on the rear end.

the weight of tanders roller various from 2 to 8 tonnes & that of two wheeled roller rations from 8 to 10 tonnes.

The ground pressure exerted by tanders rollers is about 10 to 17 kg/cm². the optimum working speed has found to be 3 to 6 km/h & about 8 Passes are adegrate for compa 20 cm layers.

4 How can you Explain the concrete eavipment used by the construction industay.

Concrete eavipments:-

- Concreting eavipment is Significant foo constroction comfe
- With the heading in advancements, today various constructi eavipment types of a gear have come up.

1. concrete batching plant:-

- A concrete batching plant is a significant gear for the corek eavipment. fixing like Sand, rock, wateo, cement, aftes that moved to concrete buildy site prepared to be poured foruse:
- Since today group plants are accessible in diff generation limits as well 20 cum/hs. batching plant, 30 cum/hr, concrete plant. 45 cum/hs.

2. Concrete miner.

- A concrete mixer is the best source for the construction. that works to save their precions raw materials from waste that cannot be tolerated.
- there are too many varieties available in concrete oniner like self loading concrete minos. Transit oniner that mounted on a trock, stationary concrete mixes.

3. concrete vibrator.

• concrete vibratory is the mechanical device used to create vibration in wet material. And remove the all air blw the concrete mix so gives more strength & life to concrete.

4. concrete Parer.

concrete parer has advanced the construction technology by securing the concrete from unemployed wastage. parer is a kind of moreable constroction machine that consists of a Paring area used in store the materials while working or busy road, highway & other plastic traffic predestrain can cause the deficincies while they working.

5. concrete tank.

• concrete tanks are used to save both labour & machine costs because they need to be built of construction sites & installed on the peat-position, Basicaly the tank is used to make concrete material by concrete material by points water, concrete cravels in it.

Explain in detail about Iso 9000 quality system.

5 Iso 9001:2000 - A format set of standards that are internationally recognized is always more preferable to standards of customers or contractors.

Iso 9001 standards have been derised by an international committee and are a formal set of quality management syste

Iso 9001 does not deal with any particular product but rather assesses the system as a whole.

An organization accredited by Iso used to be audited o the basis of 20 clauses contained is Iso 9001:1990

Clause 4.1 :- management responsibility.

Quality policy - To ensure the organisations commitment to quality.

organisation - To establish who is responsible for what management. Review - it establish that the quality system in working.

Clause 4.2 :- Equality system

General - To have a 'quality manual

Quality system Procedures - to set procedures and to ensure that they are followed.

Clause 4.3 :- Contract review.

Purpose - to ensure that the firm understands & meets its customer's requirments.

Clause 4.4 :- Design control.

Purpose - to translate customer's need into specification - design & development planning, identification & allocators of resources, organisational & technical interfaces, design & valid

Clause - 4.5 :- Document control.

Purpose - To Provide Precisely the document or information needed - review and approval of documents by authorized pers

Clause 4.6 :- Purchasing.

Purpose - to avoid problems caused by purchased material.

Clause 4.7 - control of customers

Purpose - to ensure that the customer fullfillment of his requirments.

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Ananthagiri (V & M), Kodad, Suryapet (Dist), Telangana.

Program		
B.Tech. ✓	M.Tech.	M.B.A.

YEAR	SEMESTER	MID EXAMINATION
IV	II	II

HALL TICKET NO.									
2	0	C	1	1	A	0	5	0	4

Regulation : R18 | Branch or Specialization: CSE

Signature of Student: Abhiraj

Course: Project Management

Signature of invigilator with date: 10/11/24

Signature of the Evaluator:

Q.No. and Marks Awarded										
1	2	3	4	5	6	7	8	9	10	11
1	1	1	1	1		5	5	—	—	5

Maximum Marks: 20 | Marks Obtained: 20

(Start Writing From Here)

PART-B

Answer the following:

7)Ai Fire Safety:-

1) Fire Safety can be prevented at the planning and managing of the construction site.

2) All the combustible materials shouldnot be placed in the surroundings of the construction site.

3) We have to follow fire safety measures, in construction sites, so that we can save the lives of the workers, can also decrease the damage caused.

Preventive Measures:-

1) Smoking should not be done near the construction areas.

2) High-intensity lights and heaters should be connected at a proper place by a wellknown technician.

3) All the electrical equipment in the construction

Processes in Fire Safety:-

1) Fire Safety Legislation:-

1) In fire Safety Legislation we have all the acts which are used to know the importance of fire safety.

2) The Dangerous Substance and Evolving Atmosphere Resolution Act in 2002.

3) The Construction Design and Management ACT (CDM) in 2007.

2) Fire preventive methods:-

1) In a building or industry constructing the emergency exists.

2) Due to emergency exists the damage caused can be reduced.

3) Emergency call:-

In this we can also use the emergency calls to call the fire engines and the water pipes.

4) Fire Warning System:-

1) In this Construction sites during the time of fire accidents the company will alert the workers with the alarm.

2) When the alarm is rang all the workers will exit through emergency exit ways to save their lives.

5) Fire Safety equipment:-

1) During the fire accidents fire extinguisher axe used to set off the fire.

2) [illegible]

2)A: Classification of Contracts:-

1) A Contract is a legal Agreement between a contractor and a client.
2) There are various contracts they are classified into many types. They are:-
i) Unit Contract.
ii) Percentage Contract.
iii) Cost-plus Percentage Contract.
iv) Time and Material Contract.
v) Lum-Sum Contract and
vi) Target Contract.

3) Unit Contract:-
Unit Contract is a contract in which the entire contract is owned by a Single Person. The profit and loss is beared by the owner. All the investment is invested by the owner.

4) Percentage Contract:-
In Percentage Contract it is shared by multiple people according to the percentages. The investment is also from multiple sources. The final profit is also shared according to their percentages.

5) Cost-plus Percentage Contract:-
In Cost-plus Percentage Contract it includes the high cost and divided according to the Percentages. Multiple people will invest in the contract and the contract is

6) Time and Material Contract:-

In Time and Material Contract it specifies about the time take by doing this work. It will specify the time for the completion of work. The materials which are used are also specified in this Contract.

7) Lum-Sum Contract:-

This Contract Specifies about the amount required to complete the work. For each material or each work the cost is specified.

8) Target Contract:-

In this Contract the time scheduled is fixed. The work should be completed only within that span of time. The Target should be completed in this Contract within the specified Time.

So, These are the Classified Contracts.

11) Dispute Resolution Methods:-

1) In Dispute Resolution we follow various Methods.

2) The Methods in Dispute Resolution are:-

i) Negotiation.

ii) Mediation.

iii) Expert determination.

iv) Adjudication.

In Negotiation the problem arised between the contractor and client is solved within themselves. The claims are negotiated and solved among them.

4) Mediation:-

In Mediation to solve the dispute the mediators are involved. The mediators will provide multiple ways to solve the problem. Among these ways the contractor can choose any one best way.

5) Expert Determination:-

In Expert Determination the solutions are suggested by the experts. To solve a dispute we approach expats and they will provide us a solution.

6) Adjudication:-

In Adjudication Only one solution is suggested for a dispute and that solution is advised for the client. Only a single solution is advised.

7) Arbitration:-

In this Arbitration all the court rules are followed to get a solution. The both sides are judged and the final decision is taken out.

8) Legalisation:-

Legalisation is a process in which every step is carried out legally.

PART-A

Answer all the questions

1) A:- 1) Personnel safety should be taken by every person who is working in a Construction site or visiting it.

2) To ensure personnel safety we should carry PPE, helmet, face shield, safety glasses, masks, boots etc.

2) A:- Project estimation is a process which is done in advance before starting a project to understand the project, to estimate the usage of resources, materials in the project and also the cost of the project.

3) A:- 1) Contract document is a legal agreement between the contractor and the client.

2) The contract document consists of general conditions, special conditions, specifications, drawings, construction schedule, schedule of values etc.

4) A:- 1) The Arbitration process is highly costly.

2) It is a time consuming process.

3) It requires many people to solve the dispute.

4) The Solution may not be satisfying to the client

5) A) Project closure is a process in which it describes about the completion time of the project and also the steps included at the end of the project. These steps are taken care of Project closure.

Name: SK. Khalid subject: PM
H.T.No: 21C15A0419
IV B.Tech II SEM
II MID Assignment

24/25 = 5 Appr

(1) Explain about fire safety and Electrical safety in the Construction

A: • fire prevention must for that reason be a top main concern when planning and managing Construction work. Construction sites are at an amplified hazard of fire owing to a range of factors.
• The presence of Combustile waste materials, solvents, hot works processes and unfinished Electrical Systems. There is also amplified risk of destruction, trespass and malicious acts.
• The nature of the incomplete building and the storage of buildi materials on site which are often Combustile surges the damag Caused once a fire does take hold, and can also pose bigger risks to fire and rescue teams.
• The Combination of hazardous activities, such as hot work, large quantities of fuel, flammable liquids, woods liquefied gas, and potential issues with Escape mean that Construction sites poses a very real fire risk.

fire prevention on the site:

• plan chosen areas for waste with fire and Emergency procedures in place to curb and deal with a fire should it break out.
• Clear away rubbish and waste frequently to the choosen areas. don't let waste materials build up around the site.
• never try to dispose of rubbish by burning it. site 'bonfires' are prohibited and Can get out of Control Easily.
• Electrical Systems, Comprising short-term supplies, must only be installed by a skilled Electrician and must be frequently maintained.
• Do not smoke in areas of high fire risk & chosen 'no smoking' areas. dispose of matches & cigarette butts cautiously.
• Control all hot works by a permit to work systems to make certain that risks are effectively controlled.

Electrical safety:

- Every construction site is covered with electrical hazard, regardless of whether you are tearing down a structure or building one from the ground up. In order to keep your workers & work place safe you must follow safety precautions across the site.
- Here safety tips that you must follow in the construction site.

1. personal protection: it should come first as compared to any other piece of safety Equipment as it directly protects you against electrical mishaps. The amount of personal safety protection required is based on your potential exposure to electricity.
2. Testing Equipment: Never handle any Electrical wiring or equipment if you don't know how to operate it. The electrical power testing Equipment provides the necessary protection from unwanted and potential daily shocks.
3. Cord protectors: one good electric safety practice includes use of safe Extensions cords & outlets strips. As an Extra measure, use Cable covers and Cord protectors.
4. voltage regulators and Circuit breakers: They are Critical pieces of safety Equipment that curb the problem before it gets worse Always use a surge protectors to shut off the work site's power supply during an Emergency.
5. precautions: Some Electrical hazards will occur & they would be out of your control. however, you can control some and reduce the risk of Electrocution by being Cautious at the work site. some precautions includes knowing where the Electrical wiring will be as issue on a Construction site and label it for safety measures & using ground fault ~~ckt temperatures~~ interrupt for all receptacle outlets to prevent electrical shock.
6. Equipment user:- using an Electrical Equipment at the workplace can end up becoming a very natural and Comfortable thing for the workers. This may lead to improper use of tools & be practicing unknown hazards without realizing. Training the staff properly will help them identify the unknown improper short cuts & reduce the

7. identifying problems: The dangers presented by the Construction sites must never be overlooked. Encourage your workers to practice identifying any kind of electrical hazard, such as identifying a distinct burning smell. make a safety checklist and Incorporate it into your daily routine.

8. Risk assessments: Carry out an exhaustive & Comprehensive risk assessment before any kind of work starts on the Construction site This helps in identifying the potential Electrical hazards and Ensure that suitable Control measures are in place to prevent them from Causing harm to workers.

(2) Demonstrate the stages of contract managment?

Ans: Contract managment at its best is about managing risk, and managing relationships. in a simple form, a contract is a document describing a relationship blw two parties, what Each of them agrees to do, and who carries the risk if things don't turn out as planned.

stages of Contract managment:

, it plays a significant role in the End-of-quarter crunch and are broken up into stages to Organize efforts and structure the typical Contract process. when done manually, Creating a Contract Can prove quite time-Consuming. The process in the stages of Contract managment includes several of the following steps.

- initial requests: The process begins by identifying Contracts and pertinent documents to support the Contract's purpose.
- Authoring Contracts: writing a Contract by hand is a time-Consuming activity, but through the use of automated Contract managment systems, the process Can become quite streamlined.
- Negotiating the Contract: upon Completion of drafting the Contract, employees should be able to Compare versions of the Contract and note any discrepancies to reduce negotations time.
- Approving the Contract: The instance in which most bottlenecks occur is getting managment approval. users Can pre-Emotively Combat this by creating tailored approval workflows, including parallel & serial approvals to keep decisions moving at a rapid pace.

• Execution of the Contract: Executing of the Contract allows to control and shorten the signature process through the use Electronic signature and fax support.

• obligation managment: This requires a great deal of project managment to ensure delivearables are being met by key stakehold and the value of the Contract isn't deteriorating throughout its early phases of growth.

• Revisions and amendments: gathering all documents pertinent to the Contract's initial drafting is a difficult task. when overlook items are found, systems must be in place to amend the Oligi nal Contract.

• Auditing and reporting: Contract managment does not simply Entail drafting a Contrait & then pushing it into the filing Cabinet without another thought.

• Renewal: using manual Contract managment methods can often result in missed renewal opportunities and business revenue loss. Automating the process allows an Oganization to Identify renewal opportunties and Create new Contracts.

(3) Explain the types of project estimates?

A: Types of project Estimates:

1. Detailed Estimate:

• This includes the detailed particulars for the quantities, rates & Costs of all the items involved for the satisfactory completion of a project. This is the best & the most accurate Estimate that can be prepared.

• A detailed Estimate is accompained by - report, specifications, detail drawings showing plans, design data and Calculations and, basis of rates adopted in the Estimate.

2. preliminary or approximate or rough Estimate:

• This is an approximate Estimate to determine an approximate Cos in a short time and thus Enables the authority Conlerned to Consider the financial aspect of the scheme, for according Sanction to the Same.

• Such an Estimate is framed after knowledge the rate of simila

works & from practical knowledge in various ways for various types of works.

3. quantity Estimate or quantity Survey:

- This is a Complete Estimate or list of quantities for all works items required to Complete the Concerned project. The quantity of Each item of work is worked out from the respective dimensions on the drawing of the structure.
- The purpose of the bill of quantities is to provide a complete list of quantities necessary for the Completion of any Engineering project

4. Revised Estimate:

- A revised Estimate is a detailed Estimate of the revised quantities and rates of items of works originally provided in the Estimate without material deviations of a structural nature from the design originally approved for a project.
- it is a accompained by a Comparative statement abstract form showing the probable variations for quantity, rate, and amount for Each item of work of the project Compared with the original Estimate side-by-side stating the reasons for variations.

5. Supplementary Estimate:

- during the progress of the work, some modifications or additions due to material deviation of a structural nature from the design originally approved may be thought necessary for the development of a project.
- It includes all such works. The method of preparation is the same as the detailed Estimate.

6. Complete Estimate:

- it is related to the work in addition to the main Contract to the 'detailed Estimate'

7. Annual maintenance or repair estimate.

- After Completion of a work, it is necessary to keep the maintenance aspect in view for its proper functioning. An Estimate is prepared for the items which require renewal, replacement, repairs, etc.
- the total estimated cost of maintenance of a structure is generally kept within the prescribed limits on the percentage basis of the Cost of Construction of the structure and its importance.

4) Explain dispute resolution methods in detail?

A: once a construction dispute arises, the parties to the contra may find themselves wondering what the best course of acti is.

· Claims can cost both parties & end up disrupting the whole projec There are things a Contractor can do to avoid a dispute.

methods:

1) negotiation:

A negotiation clause basically includes the agrement that if a cause for a dispute should arise between a Contractor and a project owner, these parties will attempt to reach a just & satisfactory resolution blw themselves before moving into other means.

2) mediation: A mediation clause suggests the inclusion of a neutra third party in the dispute situation to help mediate the process of resolving the dispute mediation is not legally binding in anyway but can be an effective wayout of a station which could otherwise deteriorate.

3) Expert determination: An alternative to mediation is Expert determination which is used to resolve disputes of a specialist nature or in cases where there is a valuation dispute requiring a Specialists opinion.

4) Adjudation: The adjudication method also includes a neutral third party but unlike with the mediation method, the adjudica will give a decision, whereas the mediator will assist parties in finding the resolution.

5) Arbitration: if parties decide to go for arbitration, they will agai have a neutral third party enter the situation to help resolve it. in arbitration parties agree to the arbitration who has the relevant experience to engage in the matter. Arbitration can be legally binding, depending on the jurisdiction. The costs of arbitrati can be significantly higher than that of other methods, sometimes even as high as legal procedings.

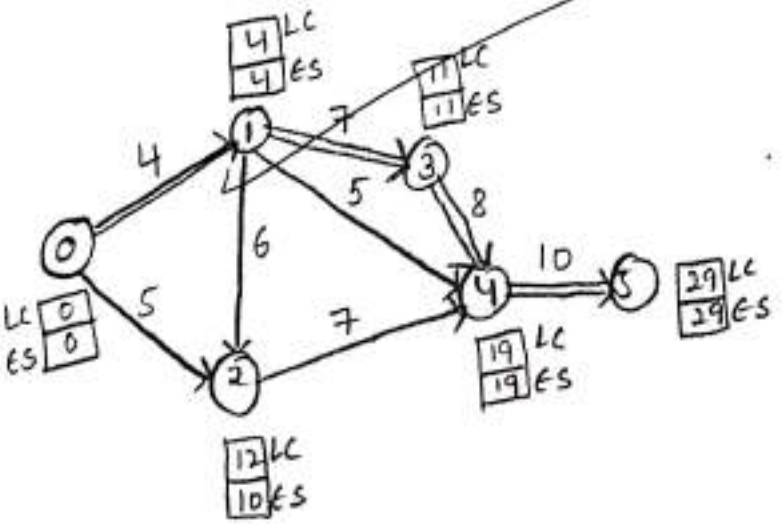
6) litigation: it is usually also included in the dispute clause, in case the partics do not find any other way to resolve the issue that have come up, litigation involues a trail & is legally binding and enforeable, thought it can also be appealed.

Draw a PERT N/w for the following & find expected mean time, variance, and critical path of the project. Also find what is the probability of project to be completed less than or equal to 23 days

Activity	Three-time estimates (days)
0-1	2-3-10
0-2	4-5-6
1-2	3-6-9
1-3	6-7-8
1-4	1-5-9
2-4	3-5-19
3-4	5-6-19
4-5	8-10-12

A:

Activity	three time Estimate	Estimated time (te) $= \frac{t_o + 4t_m + t_p}{6}$
0-1	2-3-10	4
0-2	4-5-6	5
1-2	3-6-9	6
1-3	6-7-8	7
1-4	1-5-9	5
2-4	3-5-19	7
3-4	5-6-19	8
4-5	8-10-12	10



Activity	Duration	EST	EFT	LST	LFT	$\sigma^2=\left[\frac{t_p-t_o}{6}\right]$	Remarks
0-1	4	0	4	0	4	1.77	Cp
0-2	5	0	10	0	12	0.11	
1-2	6	4	10	4	12	1.00	
1-3	7	4	11	4	11	0.11	Cp
1-4	5	4	19	4	19	1.77	
2-4	7	10	19	12	19	7.13	
3-4	8	11	19	11	19	5.43	Cp
4-5	10	19	29	19	29	0.45	Cp

Critical path:-

0-1-3-4-5

4+7+8+10 = 29 days.

if the project will be completed in 29 days, what is the propability that should be completed in 32 days.

critical activity	duration	varience
0-1	4	1.77
1-3	7	0.11
3-4	8	5.43
4-5	10	0.45
	29	7.76

$\sigma = \sqrt{7.76}$

$= 2.78$

$P(x \le 32) = P\left[\frac{x-H}{\sigma}\right]$

$= P\left[\frac{32-29}{2.78}\right]$

$= P[1.08]$

$P(1.08) = 0.8599$

$85.99\% \simeq 86\%$.

UNIT-I

FUNDAMENTALS OF CONSTRUCTION TECHNOLOGY

- **PROJECT:** A project is a group of unique, interrelated activities that are planned and executed in a certain manner to create a unique product or service with in a specific time, budget and the clients' specifications.
- **MANAGEMENT:** Management is the process of planning and organizing the resources and activities of a business to achieve specific goals in the most effective and efficient manner possible.
- **PROJECT MANAGEMENT:** It is the discipline of organizing and managing resources in such a way that these resources deliver all the work required to complete a project with in defined scope, time and cost constraints.

1.0 PROJECT PERFORMANCE DIMENSIONS

- TIME, COST and SCOPE parameters are interrelated and interactive.
- Mathematically, performance= f (scope, cost, time)
- If the scope is enlarged, project would require more time for completion and cost would also go up.
- If time is reduced, the scope and cost would also be required to be reduced.
- If any changes in cost would be reflected in scope and time.
- In recent years a fourth dimension, stakeholder satisfaction is added to the project.

2.0 INTRODUCTION TO CONSTURCTION TECHNOLOGY

- The main objective of construction technologies is towards constructing lighter and taller buildings and to provide less economical and more affordable idea's, which is always a big challenge in an era of financial crunch.
- Now a days many construction technologies are available which are chosen according to the duration of project, budget of project, nature of land, building design, requirements of contractors.
- These technologies include Precast construction system, prefabricated construction system, in-situ construction system, R.C.C or Non-R.C.C structures etc.
  Architectural work: The art of planning and designing of a building. So as to suite its purpose, giving due consideration to the site, orientation, ventilation, appearance of the building is known as architectural work. This work is done by a special person known as an architect.
  Design work: The part of designing the different parts or elements of a building so as to suite for purposes, safety and economically is known as design work. This work is done by a special person known as design manager.
  Execution work: The art of doing the construction of the building systematically according to its planning and design is known as execution work. This work is done by a special person like civil engineer, builder, contractor etc.

3.0 CONSTRUCTION ACTIVITIES

- General construction work involves all civil engineering works starting from substructure to reinforced concrete and structural steel superstructures.
- All construction activities need to be planned sequentially and executed in minimum possible time, men, machine, and materials needed to be mobilized for timely execution of all the construction works.

Sequences of Work in Building Construction

- **Paper Work:** Construction of residential building required paper work before the start of actual construction. The paper works are preparation of drawings, estimation of material cost, labor cost & contingencies, approval of drawings from City Development Authority.

- **Marking of Layout:** The approved plan boundaries are marked in the ground first and the ground inside and outside the layout is cleaned. Later the complete layout is marked on the ground with accurate dimension and orientation.

- **Excavation:** Generally, excavation is carried out for the construction of wall foundations. Excavation should be carried out as per the drawings defined lengths & widths. Suitable machines are used to excavate the earth for the making of foundation.

- **Foundation Work:** Foundation work consists of many subs works which are as follows,
  Compacting the ground: The excavation pits are trimmed and dressed as per the requirement and the bottom is compacted using hand compactors.
  PCC: To form a solid bases on which the reinforcement can be tied and footing can be placed. Plain cement concrete of the mix 1:4:8 or 1:3:6 is laid on the compacted soil in varying depth as required.
  Footing Reinforcement: Reinforcement steel bars are tied together and placed on the PCC to form a skeleton in which the concrete is poured and the column rods are taken from them.
  Shuttering: To achieve proper shaped concrete, shuttering is done as per the dimensions mentioned in the drawing. It is also done so that the concrete doesn't come in contact with the soil.
  Footing Concrete: It is very necessary to check the levels of foundation before concrete work. Concrete is poured as per drawing specs.

- **Column Casting:** Casting of columns is made by fixing the shuttering framework and concrete is poured in the formwork. The shuttering is usually removed after 24hr of casting and curing is done.

- **Construction of Walls:** Walls are constructed using many materials such as brick, wooden, precast concrete and many other. Before starting the wall construction, the base of wall is constructed first using concrete or size stone masonry. The height of the walls depends upon the floor height. Necessary opening is to given for doors, windows and ventilators.

- **Lintel:** Reinforced cement concrete beams are laid down on the top of openings. So, those loads of structure above openings not directly come on to the door frames.
- **Roofing:** Roof slab of building is poured after completion of masonry works. Now a days, roofing is of reinforced cement concrete slab. Slab thickness & reinforcement details should be according to approved drawings.

- **Plastering Work:** Form work is removed after 14 days of slab pouring. Now plaster work begins. Mortar for plaster work is generally of 1:3 or 1:4 is used. Generally, internal walls of buildings are covered with plastered layer and external walls with pointing.

- **Fixing of Doors and Windows:** In case of wooden doors & windows, frames are fixed in walls during masonry work. Panels are then fixed with hinges after plaster work. Steel and aluminum doors are fixed after completion of paint works.
- **Fixing of Electrical and Plumbing Works:** The necessary electrical and plumbing works are carried out before the final finishing works such as painting and tiles laying is done so as to reduce the damage.
- **Tiles Laying:** Majorly tiles are laid in the bathrooms and kitchen area. First the wall tiles are fixed after which the floor tiles are fixed. For flooring works, granite, marble, tiles, epoxy are also used.

- **Painting:** Painting consists of different sequences depending upon the type of finished required. 1 coat of primer and 2 coats of water-based paint is also done or 2 coat of putty and 2 coats of painting is done for the smooth finish.
- **Miscellaneous Works:** Other than all these above-mentioned works, there are other works that are carried as per the requirement of the consumer and design engineer. Terrace water proofing, landscaping works, False Ceiling, Installation of Furniture.

4.0 CONSTRUCTION PROCESS

- When many people think about what goes into a construction project, they picture big machines on job sites, methodically erecting their new building.

STEP 1: Conception (Creating A Comprehensive Vision)

- During the conception stage of your project, you begin to plan what the building will look like and what needs it will accomplish. To create a solid foundation for the project moving forward, it's crucial to begin by determining the project's overall vision.
- Master planning services can help organize your thoughts and needs into a cohesive strategy and consider all the short-term and long-term requirements for the property from the perspective of the many people who will use it.

- It will help maximize your resources and ensure you develop a new space that supports your business or organization's vision.

STEP 2: Team and Delivery Method Selecting (Choosing Your Partners)

- Choosing a team to bring your project vision to reality is a big step that will have a major influence on the outcomes you experience. The most successful projects come from teams that understand your project goals and will work as your advocate to execute that vision every step of the way.

- Once the project has been conceptualized, you'll send out the drawings to various construction firms. They'll use the construction documents to pull together a bid, and you'll then select the construction firm based on the bid and their qualifications.
- the design-build firm will take on further responsibilities that otherwise would fall to the owner, like paperwork, team coordination, and other miscellaneous administrative tasks.

STEP 3: Design (Conceptualizing the Vision & Creating Construction Documents)

- During the design phase, you'll work with the design team to turn your project's vision into drawings and blueprints. They'll be sure to consider programming and feasibility with things like the building's size and layout.
- Once that is worked out, the construction documents will be released. They often come out in three stages known as the 30-60-90 design process.
- In a design-build approach, they will be able to offer suggestions about constructability, best value, material selection, and longevity factors, and more.

STEP 4: Preconstruction & Procurement (Planning the Construction Process)

- The goal of this stage is to create a plan for building the project that's in line with your goals and vision. It will deal with budgets, schedules, and other factors essential to completing the project.
- Preconstruction is also the phase where your team will iron out the details of permitting and/or land development. This process can be a lengthy one, depending on the specifics of your site, rezoning, geographical features the site.

STEP 5: Construction (Actualizing the Design)

- As preconstruction is wrapping up, the construction phase can begin. The project team, owner, and other project stakeholders will get together to commemorate the project's start with a groundbreaking ceremony.ne is working safely, and 'll be able to address any concerns to help prevent future incidents.

STEP 6: Close-Out (Wrapping Things Up)

- As the last of the fixtures are installed and the final coats of paint go to the walls, project closeout can begin. Here's when they'll turn the building over to the owner, passing on all the knowledge that's essential to running the building.
- During this stage of the project, your construction team will wrap up the project's punch list. The project owner will receive all the project closeout information, which includes equipment warranties and manuals, and as-builts.

5.0 CONSTRUCTION SCHEDULE

- A construction schedule is a timeline of each task or milestone required to complete a construction contract, and the resources needed to complete each part.
- Every job has a building schedule, which contains a timeline of the physical work that needs to happen, like excavation, electrical installation, and inspections.

Types of construction schedules

- **Building schedule:** The overall building schedule provides a list of the work activities or scopes that are needed and shows when each activity is scheduled to take place. There are several formats and logic methodologies that are used to develop these schedules.
  Gantt chart: A Gantt chart shows each activity as a bar on a chart, with time as the horizontal axis. Colored lines or bars are used to represent the duration of each task.
  Critical path method (CPM): The critical path method (CPM) looks at the durations, predecessors, and successors for each activity and determines how long each task can be delayed without affecting the overall completion date.

Line of balance (LOB): Line of balance (LOB) scheduling offers teams that are working on repetitive projects, such as roadways or tunnels, a way to schedule their resources so that the work can continue progressing.

Q scheduling: Q scheduling is a fairly new method of scheduling and provides teams a combination of the Gantt chart and line of balance methods. It takes into consideration both a sequence of unique activities and the resources that are needed for each task.

- **Schedule of values:** A schedule of values provides a breakdown of the project's phases or scopes of work and assigns each one its portion of the contract price. This schedule is generally included with payment applications as a way to show the value of the work that has been completed.
- **Labor schedule:** A labor schedule is used by a contractor to help track their workers or crews. It involves a detailed list of the activities on a project with the type of work and the workers or crew responsible for that portion of the project. It helps contractors visualize the flow of their work on a project and also know who is working where and doing what.
- **Payment schedule:** A payment schedule is a list of the anticipated costs on a project and when they are expected to be incurred and paid. These costs may include materials, equipment rentals, labor, and other expenses. This schedule helps a contractor know when they expect payments to be due as the project progresses, so they can plan their cash flow accordingly.
- **Draw schedule:** A draw schedule is similar to a payment schedule, but it anticipates how much money will be coming in and when payments will be received. It showing how much of the project is anticipated to be complete at each draw application.
- **Submittal schedule:** The design team and project owner need to review submittals before a project can begin. A submittal schedule tracks all of these required documents, when they were submitted for review, the review status, and if/when they were resubmitted if necessary.

6.0 CONSTRUCTION RECORDS

- Records to be maintained at construction sites play important role in construction activities. If any additional work has been carried out and it is claimed during billing, these documents need to be produced as a proof.
- Maintenance of records also helps during audits of construction projects at any point of time. These documents help to defend any claims such as liquidated damages or false claims or violations of any guidelines by authorities or clients.

Records at Construction Site

The following are the various records that need to be maintained at construction site,

- **Drawings:** First and foremost, import records to be maintained on site are the working drawings approved by the clients and design engineer. There is different type of drawings required for construction Architectural drawing, Structural drawing, Plumbing & sanitary drawing, Electrical drawing, Finishing drawing etc.
- **Contract Agreement:** Contract agreement documents including all sets of drawings, including amendments, a copy of approval of municipality, corporation or urban development authorities need to be maintained at construction sites till the completion of construction projects.
- **Work Orders Book:** All the orders given by clients to the contractor's need be maintained with serial numbers, signatures and dates. These orders should be specific for works. This order should also have a compliance column.
- **Works Diary:** Works diary of a construction project should indicate contract agreement number, name of work, amount of contract, date of commencement of work, date of completion and extension time granted.
- **Tests Results Record:** This is an important record to be maintained at construction site as a proof for construction quality. This record consists of tests of various materials such as cement, sand, aggregates, water, steel reinforcement used at construction site, test records of concrete cubes, concrete cylinders, slump tests etc.

- **Cement Register:** This record is maintained with details of receipts, daily consumptions and remaining balance of cement at site.
- **Register for Approval of Samples:** This record provides details of all the samples for construction materials that has been approved or rejected by the clients. Approvals from the client is necessary for the construction materials to be used before commencement of the project.
- **Records of Changes, Deviation Orders and Amendments:** Many a times during the construction projects, there are deviations or changes or amendments to the contract documents and work activities from time to time during construction project as required by the clients. These changes can be in a drawing, specifications or additional works.
- **Measurement Books:** The measurement book is a record for all the construction activities carried out and approved by the client. These records are important for a contractor to maintain and help during billing claims. Any extra work done is also recorded in this book with notes.
- **Labor Attendance Record and Daily Wages Sheet:** Generally, for labor contractor payments, daily or every shift attendance record is kept. Apart from the above, technical staff attendance, engineers, supervisors, and peon attendance register is kept.
- **Periodic Bills Record:** Bills on work till date from the previous bill and work checked by engineer-in-charge put up for the payment.

7.0 CONSTRUCTION DOCUMENTS

- Construction documents are written, graphic and pictorial documents prepared or assembled for describing and communicating the design, location, and physical characteristics of the elements of a project necessary for obtaining a building permit and administering the contract for its construction.
- Construction documents should also show the size, section and relative locations of structural members with floor levels, column centers and offsets, and the design loads and other information pertinent to the structural design.

Contents of Construction Documents

- **Drawings:** It is important that the structural and architectural drawings be coordinated on a regular basis. The following items are usually included in a typical set of drawings: Structural drawings must show the size, section, and relative locations of all of structural members in a building, Foundation plans., Schedules for the structural members, including foundations, beams, slabs, columns, and walls.
- **Material Properties:** Specified compression strength of all concrete mixtures utilized in the structure at the ages or stages of construction for which each part of the structure is designed.
- **Design Loads:** The following design loads and information must be included in the construction documents, as per IBC 1603: Floor live load, Roof live load, Roof snow load data, Wind design data, Earthquake design data, Flood design data, Special loads

- **Geotechnical information:** Reference the soils report on drawings, show the parameters used in the structural design, and note that the soils report recommendations are to be followed. Edit the specification section for earthwork to either match the soils report or cross reference the contractor to the appendix.
- **Other Information:** Formwork and formwork accessories, Concrete mixtures, Handling, placing, and constructing, Architectural concrete, Lightweight concrete, Mass concrete, post-tensioned concrete, Shrinkage-compensating concrete etc.

8.0 QUALITY

- Quality in construction industry can be defined as the attainment of acceptable levels of performance from construction activities.
- The quality of any product or service is achieved when it conforms to the desired specifications.

- Achieving quality in construction industry in long run is a tough issue and has been a problem. Inefficient or no practice of quality management procedures will result in great loss of time, money, material, resources.

Objective of Quality in Construction

- Satisfaction of Contract Specifications
- Completion of Project within Time
- Enhancing Customer/ Owner Satisfaction
- Motivation and Empowerment of Employees
- Avoiding Disputes and Claims
- Performance based on Purpose

Quality Assurance (QA) in Construction

- Quality assurance are certain schemes that is implemented in construction in order to maintain the standard or the quality of the work in a consistent manner.
- The companies generally will have a quality assurance chart that will specify various checks at different levels.
- In general, a quality assurance plan will involve the following: Training Programs for Workers and Employees, Efficient Safety Programmed, Effective Procurement system to obtain quality resources and suppliers, Reward scheme for innovative works

Quality Control (QC) in Construction

- Quality control in construction involves periodic inspection of the construction activities and facilities in order to meet the desired standardization as per the contract.
- Quality Control is undergone by the team of QC engineers or special trained teams.
- Quality control focuses on: Setting and Practicing specific standard for construction, Determining the deviations from the standards, Standard Improvement with time.

Elements of Quality in Construction

- **Quality Characteristics:** A quality characteristic is related to the parameters with respect to which quality – control processes are judged. Quality characteristic includes strength, colors, texture, dimension, height etc. Example in compressive strength of concrete, workability of concrete in slump,
- **Quality of design:** It refers to the quality with which the design is carried out. It primarily related to meeting the requirement of the standard, functionally efficient system and economical maintainable system.
- **Quality of conformance:** It is referred to the degree to which the constructed facility conformed the design and specification. Quality of conformance is affected by field construction methodology and Inspection

Factors Affecting Construction Project Quality

The quality of construction project is influenced by various factors which are mentioned below:

- **Project Requirements:** Quality of any construction project is meeting the respective project requirements. This will satisfy the designer's requirements, the constructors & the owner's requiremen
- **Construction Organization:** Based on different studies considered it is concluded that the commitment and the leadership criteria of a construction organization will affect the quality of the project.
- **Quality Teams:** A structured environment is provided by having quality teams for the project. Practices are implemented structurally and continuously with regular quality checks. Quality teams will have structural engineers, environmental engineers, electrical, civil engineers, architects and owners to bring quality goals.

- **Participation of Team Members:** The participation of the quality team members is not only important in the planning stage but also during the construction phase of the project.

9.0 SAFETY

Construction sites are dangerous places to work. Follow these simple construction site safety rules to keep yourself, and others safe and prevent accidents.

- **Wear your PPE at all times:** When you enter the site, make sure you have the PPE you need. PPE is important, it's your last line of defense should you come into contact with a hazard on site. Safety boots give you grip and protect your feet. Hard hats are easily replaced, but your skull isn't. It can't protect you if you don't wear it.
- **Do not start work without an induction:** Each site has its unique hazards and work operations. Make sure you know what is happening so that you can work safely. Inductions are a legal requirement on every construction site you work on. Your induction is important. It tells you where to sign in, where to go, what to do, and what to avoid. Don't start work without one.
- **Do not put yourself or others at risk:** Especially on construction sites where one wrong move could put you in harm's way. You are responsible for your own behavior. Construction sites are dangerous places to work. Make sure you remain safety aware throughout your shift.
- **Follow safety signs and procedures:** Follow construction safety signs and procedures. Your employer should ensure a risk assessment is carried out for your activities. Make sure you read and understand it. Control measures are put in place for your safety.
- **Never work in unsafe areas:** Make sure your work area is safe. Know what is happening around you. Be aware. According to HSE statistics, 14% of fatalities in construction were caused by something collapsing or overturning, and 11% by being struck by a moving vehicle. Don't work at height without suitable guard rails or other fall prevention.
- **Report defects and near misses:** If you notice a problem, don't ignore it, report it to your supervisor immediately. Whatever the procedure in place on your site for reporting issues, use it. Action can only be taken quickly if the management has been made aware of the problem. The sooner problems are resolved the less chance for an accident to occur.
- **Never tamper with equipment:** If somethings not working, or doesn't look right, don't try and force something, or alter something, if you're trained to or supposed to. Never remove guard rails or scaffold ties. Do not remove machine guards. Do not ever tamper with equipment without authorization.
- **Use the right equipment:** Using the correct tool for the job will get it done quicker, and most importantly, safer. Visually check equipment is in good condition and safe to use before you start.

10.0 BUILDING CODES AND REGULATIONS

- Building codes are a series of ordinances enacted by a state or local governmental entity.
- The government establishes requirements and standards to protect people from unsafe living and working conditions.
- Codes regulate building construction & building use in order to protect the health, safety & welfare of the occupant.
- Codes express all aspects of construction including structural integrity, fire resistance, safe exists, lighting, electrical, energy conservation, plumbing, sanitary facilities, ventilation, seismic design & correct use of construction materials.

Purpose of building codes

- Ensure public health and safety throughout a building.
- Most have come into play "after-the-fact" as a learning experience from a major tragedy.
- Construction requirements
- Hazardous materials or equipment used in the building
- 75% of all codes and standards deal with fire
- Energy conservation
- Accessibility

National building code

- The National Building Code of India (NBC) is a national instrument providing guidelines for regulating the building construction activities across the country.
- The National Building Code was first published in 1970 at the instance of Planning Commission and then revised in 1983.
- It serves as a Model Code for adoption by all agencies involved in building construction works be they Public Works Departments, other government construction departments, local bodies or private construction agencies.
- The Code mainly contains administrative regulations, development control rules and general building requirements; fire safety requirements; stipulations regarding materials, structural design and construction (including safety); and building and plumbing services.

REGULATIONS

- **Green Building and Sustainable provisions:** Rainwater harvesting, wastewater reuse, installation of solar rooftop PV rooms.
- **Provisions for disabled, elderly and children:** Access path/ walkway, toilet, parking, drinking water, stairways, lifts, refuge and designing for children safety.
- **Structural safety and security:** It Include disaster management guidelines for different building types. Prevention measure against 'soft stores' in multi-story buildings and proof checking of structural designs.
- **High rise building regulation:** Structural safety requirements for high rise buildings, open spaces, building components, services and fire safety parameters.
- **Swachh Bharat Mission:** Revised regulations for adequate toilet facilities for women and public conveniences such as separate public toilets for visitors in public buildings.
- **Communication technology:** Provision for effects of electromagnetic radiations in built spaces by identifying emissions and sources.
- **Conservation of heritage sites:** States the responsibilities for owners of heritage buildings regarding repairs, restrictions on development, preservation of the beauty of the area and penalties.
- **Ease of doing business:** Introduce provision for online building plan approval process, generation of reports/approvals, automatic generation of the completion certificate, clearance of master plans and integration of a "Single Window" process for users.
- **Building plans approval:** Includes different bodies in charge for clearance of building plans before construction such as Urban Art Commission (UAC), Airports Authority of India (AAI), Metro Rail Corporation (MRC), Heritage Conservation Committee (HCC), etc. to grant No Objection Certificate (NOC)/ approvals on the proposed building plans to the local bodies.

11.0 CONSTRUCTION METHODS

- Modern methods of construction (MMC) are innovative ways of building structures, which are increasingly being used in the construction industry.
- These modern methods of construction deliver a range of benefits to construction projects, often making it possible to save time and money, as well as produce excellent work.

Methods

- **Modular Buildings/3D Volumetric Construction:** Constructing modular buildings is all about creating parts of the building off-site and then bringing them on-site. By building 3D modules off-site, it's possible to save time and money, as well as carry out quality control. They can be excellent for consistency for the development of modular homes, in addition to hotels and similar buildings. Light gauge steel is ideal for this purpose, as it is light, durable, and versatile.

- **Flat Slab Construction:** Flat slab construction involves the use of flat slabs of concrete that are reinforced and supported with concrete columns. This method of construction removes the need for beams, with the load of a slab placed on supporting columns and a square slab called a drop panel. This MMC construction method offers flexibility in design layout, as well as reducing the amount of time required for construction.

- **Twin Wall Technology:** Twin wall technology is one of the modern methods of construction that combines precast concrete and in-situ concrete. Using both of these methods, it's possible to benefit from both speed and structural integrity. The walls are created by separating two wall slabs with a cast in lattice girders. After joining together and reinforcing the walls, the gap between them is filled with concrete. As well as being a faster method of construction, it's more economical and is often used together with precast floors.

- **Hybrid Construction:** Hybrid construction or semi-volumetric construction combines modern construction methods of volumetric/modular units and panel systems. Areas that are highly utilized such as kitchens and bathrooms can be created as volumetric units, while the rest of the building is constructed using panels. This allows for the best parts of each construction method to provide benefits, including fittings in the volumetric units and flexibility from the panel system.

- **3D Printed Construction:** 3D printing is continually being used in new and innovative ways, including in the construction industry. 3D printed construction is particularly useful for creating prototypes, as well as for creating complex components that have more challenging shapes. 3D printing uses the sequential layering of materials to build up the element being constructed.

12.0 EARTHWORK & EXCAVATION

- Generally, all the Civil Engineering projects like roads, railways, earth dams, canal bunds, buildings etc. involves the earth work.
- This earth work may be either earth excavation or earth filling or sometimes both will get according to the desired shape and level.
- Basically, the volume of earthwork is computed from length, breadth, and depth of excavation or filling.

Types of Soil

- **Soft / Loose Soil:** Generally, any soil which yields to the ordinary application of pick and shovel, or other ordinary digging implement; such as vegetable or organic soil, turf, gravel, sand, silt, loam, clay peat, etc.
- **Hard/Dense Soil:** Generally, any soil which requires the close application of picks, or jumpers or scarifies to loosen; such as stiff clay, gravel, cobblestone, water bound macadam's and soling of roads.
- **Mud:** A mixture of soil and water in fluid or weak solid state.
- **Soft/Disintegrated Rock (Not Requiring Blasting):** Rock or boulders which may be quarried or split with crowbars. This will also include laterite and hard conglomerate.
- **Hard Rock (Requiring Blasting):** Any rock or boulder for the excavation of which blasting is required.
- **Hard Rock (Blasting Prohibited):** Hard rock requiring blasting but where blasting is prohibited for any reason and excavation has to be carried out by chiseling, wedging or any other agreed method.

Method of calculating the earth work quantities

- **Lead and Lift:** It is the average horizontal distance between the center of excavation to the center of deposition. The unit of lead is 50m. It is the average height through which the earth has to be lifted from source to the place of spreading or heaping.
- **Excavation Earthwork:** Foundation trenches shall be dug out to the exact width of foundation concrete and the side shall be vertical. If the soil is not good and does not permit vertical side, the sides should be back or protected with timber shoring. Excavated earth shall not be placed with in 1m (3') of the edge of the trench.
- **Finish of trench Earthwork:** The bottom of foundation trenches shall be perfectly levelled both longitudinally and transversely and the side of the trench shall be dressed perfectly vertical from bottom up to the lest thickness of loose concrete so that concrete may be laid to the exact width as per design.
- **Finds:** Any treasure and valuables or materials found during the excavation, shall be property of the government.
- **Water in foundation:** Water, if any accumulates in the trench, should be bailed or pumped out without any extra payment and necessary precautions shall be taken to prevent surface water to enter into the trench.
- **Trench fillings:** After the concrete has been laid masonry has been constructed the remaining portion of the trenches shall be filled up with earth in layers of 15cm (6") and watered and well rammed.
- **Measurement:** The measurement of the excavation shall be taken in cu m (cu ft) as for rectangular trench bottom width of concrete multiplied by the length of trenches even though the contractor might have excavated with sloping side for his convenience.

13.0 PILING

- Piling is the process of inserting structural piles into the ground that will become the base of the building. Piles are required where soil and earth are performing poorly and are used to spread the load of a building and firm the ground.
- Piling is crucial to the stability and success of many building structures – including homes, bridges, viaducts, and roads.
- Piles can be made from metal, concrete, wood or steel. In construction, they support buildings with weak soil and are driven into the ground by hammering.
- There are two main types of pile, these are replacement and displacement. Replacement piles are put into holes or augured out of the earth to replace it. Displacement piles are pre-formed and driven into the ground.

Types of piling

When determining the best piling type for a project, including: The depth of the excavation, The angle at which the pile needs to be installed, the environmental issues that impact local residents

- **End-bearing piles:** The bottom of end-bearing piles rests on a layer of strong soil or rock. Engineers design this type of pile to transfer the heavy load of a building through the pile onto the strong layer. It essentially is a column that cuts through a weak layer of ground so that a structure can remain upright with the support of the strongest layer underneath.
- **Friction piles:** Friction piles are cylindrical. They use their full height to transfer the forces a building generates into the soil. In a friction pile, the amount of load a pile can support is directly proportional to its length. This also means that at greater depths, the pile can hold more weight.
- **Bored piles:** Bored piles need to be augured into the ground to form a hole that workers can later fill in with poured concrete. Construction projects in cities use bored piles because the installation process results in less vibration when compared to other methods.
- **Driven piles:** Driven piles need a lot of force to be hammered into the ground. This type of pile is common for foundations that have non-cohesive soils or soils that contain many contaminants.
- **Screwed piles:** Screw piles look like large steel screws that need to be fastened into the ground using a similar circular motion regular screws to attach to other surfaces, such as wood.
- **Timber piles:** Engineers have used timber piles for thousands of years in construction. Timber piles are precast off site and installed with the driving method. They are a highly economical, safe and efficient foundation solution for temporary and permanent structures.
- **Steel piles:** Construction workers install steel piles with impact or vibration hammers that can penetrate sturdy soil and rock. Depending on the support that your project needs, steel tube piles come in different diameter size options too.

How does piling work

- The job of the pile is to distribute the weight of the structure evenly. They are placed into the ground using a pile driver. Holding the piles perfectly vertical, this machine hammers each structure into the ground and also acts as a crane.
- **Bespoke piling installation:** Occasionally, it can be difficult to install piles in sensitive locations due to the large soil vibrations and disruption. Certain locations require minimal disturbance; therefore, we specialize in mini piles/micro piling. Mini piling works by digging into the ground with the appropriate apparatus, lowering the concrete pile into the hole and pouring concrete gaps between the pile and the earth.

- Building foundations are often weak to bear a load of superstructure without any support. These support many include soil reinforcement techniques, techniques to reduce the intensity to load acting on the building foundations, and methods to transmit loads to deeper strata.
- Soil reinforcement techniques include geopolymers or chemical treatments to improve soil load-bearing capacity. Mat or raft foundations can be used to distribute evenly the load on the building foundations.

How are piling types used in construction

The following describes three common methods of using piling types in construction:

- **Driven pile foundations:** Concrete, steel and timber are the most common materials used to make piles for the driven pile foundation method. Concrete piles are precast before they arrive at a construction site. Similarly, contractors order prefabricated steel and timber piles that they can drill directly into the soil with a piling hammer. In granular soils, these piles displace an equal volume of soil, helping the soil become more solid. This compaction of soil increases its density; and therefore, its bearing capacity.
- **Cast-in-situ pile foundations:** Cast-in-situ foundations use concrete piles. Rather than bringing in precast piles to the construction site, workers drill holes into the ground, place steel reinforcements inside and then fill the hole with concrete instead. This allows them to tailor the depth of the foundation as per the project's needs and use piles with a smaller diameter than the ones used for driven pile foundations.
- **Combined pile foundations:** Combined pile foundations use a mix of the driven pile foundation process and the cast-in-situ pile foundation process. Thus, it retains the advantages of each method.

Problems in Bored Piles Constructions

- **Deterioration of steel or concrete:** The concrete and steel parts of the pile can be damaged during the construction process. Moreover, they can have also some initial defects. To overcome this, proper care should be taken during the fabrication and construction process. A damaged pile may not be able to resist the desired load.
- **The collapse of sides of piles:** The sides of piles can collapse if the casing is not installed or it is not properly closed. In such cases, proper care should be taken.
- **Settlement of the adjacent area:** During the driving of piles, vibrations are created. This vibration can cause a rise in pore water pressure in surrounding soils, which will then reduce their stability, driving piles in the water head can reduce the number of vibrations transferred to surrounding soils.
- **Excessive water in pile holes:** Groundwater can flow into the pile holes which may also result in excessive water in the holes. To overcome this issue bentonite slurry or steel casing should be employed.

14.0 CONCRETE

- It is a material extensively used in the construction process and is made by mixing aggregate, cement, small stones, sand, gravel, and water. All the components bond together to create a stone-like material.
- It solidifies and hardens after mixing with water and placement due to a chemical process known as hydration. It binds other building materials together.

Advantages of Using Concrete in Construction

- **Concrete is Economical:** The production cost of cement concrete is very low. Again, it is inexpensive and widely available around the globe when compared to steel, polymers and other construction materials. Major ingredients of concrete are cement, water, and aggregates. All of these are readily available in local markets at a low cost.
- **Concrete Hardens at Ambient Temperature:** Concrete sets, hardens, and gains its strength at regular room temperature or ambient temperature. This is because cement is a low-temperature bonded inorganic material. Thus, concrete can be used irrespective of ambient weather conditions and optimized with admixtures if required.

- **Ability to be Cast into Shape:** Concrete can be poured into various form-works or shuttering configurations to form desired shapes and sizes at the construction site. Concrete can be cast into complex shapes and configurations by adjusting the mix.
- **Energy Efficiency in Production:** The amount of energy required for the production of concrete is low compared with steel. For plain cement concrete, only 450–750 kWh/ton energy is required and that of reinforced concrete is 800–3200 kWh/ton. Production of structural steel demands 8000 kWh/ton or more to make, which is almost 3-10 times the energy consumption.
- **Excellent Water Resistance Characteristics:** Concrete can withstand water without serious deterioration compared to wood and steel. Due to this property, concrete is ideal for underwater and submerged applications like for building structures, pipelines, dams, canals, linings and waterfront structures. Pure water is not deleterious to concrete and not even to reinforced concrete, chemicals dissolved in water such as sulfates, chlorides, and carbon dioxide causes corrosion.
- **Ability to Consume and Recycle Waste:** Many industrial wastes can be recycled as a substitute for cement or aggregate. This includes fly ash, slag, also known as ground granulated blast-furnaces slag, waste glass, and even ground vehicle tires in concrete. Thus, concrete production can significantly reduce environmental impacts due to industrial waste.
- **Multi-Mode Application:** One of the major advantages of concrete is its ability to be used in different application methodologies. Concrete is hand applied, poured, pumped, sprayed, grouted and also used for advanced applications like concreting in tunnels.

Types of Concrete

- **Plain or Ordinary Concrete:** It is one of the most commonly used types of concrete. In this type of concrete, the essential constituents are cement, sand and coarse aggregates designed and mixed with a specified quantity of water. Plain concrete is mostly used to construct pavements and buildings, where very high tensile strength is not required. It is also used in the construction of Dams.
- **Lightweight Concrete:** Any type of concrete having a density of less than 1920 Kg/m3 is classed as lightweight concrete. The single important property of lightweight concrete is its very low thermal conductivity. Lightweight Concretes are used, depending upon their composition, for thermal insulation, for protecting steel structures.
- **High-Density Concrete:** This type of concrete is also called heavyweight concrete. In this concrete type, the density varies between 3000-4000 Kg/m3. These types of concrete are prepared by using high density crushed rocks as coarse aggregates. It is mostly used in atomic power plants and other similar structures because it protects all types of radiation.
- **Reinforced Concrete:** It is also called RCC (Reinforced Cement Concrete). In fact, it is because of the combined action of plain concrete (having high compressive strength) and steel (having high tensile strength). The steel reinforcement is cast in rods, bars, meshes, and all conceivable shapes.
- **Precast Concrete:** This term refers to numerous types of concrete shapes that are cast into molds either in a factory or at the site. However, they are not used in construction until they are completely set and hardened in a controlled condition. Some of the examples of Precast Concrete are; precast poles, fence posts, concrete lintels, staircase units, concrete blocks, and cast stones, etc.
- **Prestressed Concrete:** It is a special type of reinforced concrete in which the reinforcement bars are tensioned before being embedded in the concrete. Such tensioned wires are held firm at each end while the concrete mix is placed.
- **Air Entrained Concrete:** It is a specially prepared plain concrete in which air is entrained in the form of thousands of uniformly distributed particles. The Volume of air thus, entrained may range between 3-6 percent of the concrete. The air entrainment is achieved by adding a small quantity of foaming or gas-forming agents at the mixing stage.
- **Rapid Hardening Concrete:** This type of concrete is mostly used in underwater construction and in repairing roads. Because its hardening time is significantly less, it can be hardened in just a few hours. They are also used in building construction, where the work should be done fast.
- **Asphalt Concrete:** Asphalt concrete is a combination of aggregates and asphalt. It is also known as Asphalt. They are vastly used in the highways, airports, as well as in the embankments. They can be hardened in just an hour.

- **Shotcrete:** Shotcrete is concrete prepared in the same manner as ordinary, but the difference is that they are placed differently. They are placed with the help of higher air pressure through nozzles. The benefit of this technique is that the compaction and placing of concrete will be done simultaneously.
- **Ready-mix Concrete:** This concrete type is prepared in concrete plants and transported with the help of truck-mounted transit mixtures. Once they are reached at the site then, there is no further treatment necessary.
- **Self-Compacted Concrete:** These types of concrete are compacted by their weight, mean by the process of consolidation. There is no need to use a vibrator or doing manual compaction. The workability of concrete is always high in this type. That is the reason it is also known as flowing concrete.

15.0 CONCRETING

- Concrete is a product obtained artificially mixed, by hardening of a mixture of Cement, sand, gravels, and water in predetermined proportions. The process of mixing and pouring it into the desired location is called Concreting.
- Concreting is the major and milestone activity in a construction project followed by reinforcement & formwork in construction.
- Concretes are used in major structural elements of a structure like foundations, beams, columns, walls, slabs, etc.

The process of Concreting

- **Activities before concreting:** As the PCC is done just below the foundations, we have to excavate the earth first and then back filling is done for some cases and sometimes PCC is done directly over the soil. In the case of RCC, making and laying of reinforcement is done as per the bar bending schedule then formwork is done to pour the concrete in the desired shape or size according to the design of the structure.
- **Batching or mixing of concrete:** Batching and mixing of concrete are the prime activity in concreting works. The mixing of concrete can be done in many ways, there are generally three types of mixing done in terms of production method

  Hand mixing: The process of mixing is of two types Nominal mix and Design mix. The nominal mix is done up to the M25 grade of concrete. Higher grades are generally done by design mix concrete. Now all the ingredients are measured in the batch box one by one and they are dumped into a mixing plate or platform and they are being mixed by shovel and spade in case of hand mixing. 10 percent of cement is added extra if it is hand-mixed concrete then the process of mixing is to be done at least five minutes.

  Machine Mixing: For machine mixed concrete aggregate stones are measured first and dumped into the hopper of the machine the sand is measured in format/batch box and dumped over the stones finally cement is added at the top and all the materials are poured into the running drum of the machine followed by adding some water into the drum and it is mixed about 2 minutes minimum before discharging the mixture.

  Ready-mix concreting: Ready-mixed concrete is either produced in factories or in large automatic batching plants installed at large construction projects where a large volume of concrete is required and the quality of concrete is the foremost concern. In this type of mixing all the materials like cement, sand, aggregate, and water are laboratory tested individually.
- **Checking Of Quality Before Concreting:** After mixing and discharging the concrete some quality checks are conducted at the site by taking the specimen of concrete. A cube test is performed to check the compressive strength. And workability of concrete is determined by conducting various tests like (1) Slump test (2) Compacting factor test (3) Vee-Bee test (4) Vibro-workability test.
- **Transporting Of Concrete:** Transporting concrete done in many ways by using different types of machines. In the case of concrete mixed at the site, it is transported from one corner to another corner of the site using manual chute carts or mini dumpers or even using a shovel loader machine. For the case of concrete is imported from outside of construction site from a batching plant and in case of large site transit mixtures are used it is a special type of mixing drum mounted on a truck to transport the

concrete from place to place. And moreover, if the concrete is to be lifted at upper floors in case of a Highrise building construction concrete pumps are used and to execute large areas of concrete and conducting it faster boom-mounted pressure pumps are used.

- **Pouring of Concrete:** The main objective is to pour the concrete into the proposed formworks after we receive the concrete, we should start pouring it into the desired location without any further delay, concrete work is to be completed within a certain amount of time before it gets sent.
- **Compaction Of Concrete:** We shall take care to use a suitable type of immersion or surface vibrators, we shall take care to avoid vibration and bleeding, Insert Immersion vibrator minimum 100 mm away from the shuttering face vertically to the full depth, and withdraw vertically and slowly, do not drag. Don't allow the needle to touch the reinforcement.
- **Removal Of Formworks:** After concreting is completed, formwork has to be released for further use and to proceed to the next stage of the project. There are some standardized periods of removing the formworks.
- **Curing Of Concrete:** Curing is the process of keeping the concrete hydrated at least for seven days after removal of formwork, and maybe some more depending on the structure as per the requirement of Engineer-In-Charge of the project.

16.0 FORMWORK

- Formwork is one type of temporary mold in which concrete is poured to cast the required shape of concrete. Formworks are made from timber or steel, the surface in contact with the concrete being selected to give the required finish.
- Generally, once the concrete has gained sufficient strength, the formwork is removed although in some circumstances it may be left in place (permanent formwork).

Importance of Formwork in Construction

- Formwork mainly associated with concrete. It helps in producing smooth finished surface of the concrete.
- No doubt formwork is essential for any concrete structures can be constructed quickly and in the most affordable way.
- Formwork helps in lowers the timeline and costs of the project by lowering the floor-to-floor construction cycle time, which means more projects can fulfill their budgetary demands.

Types of Formworks in Construction

- **Timber Formwork:** Timber formwork is the most common type of formwork among all others. Timber formwork is the oldest type of form used in construction. It offers onsite fabrication of the required shape and size. It is easily used in any construction but it may prove time–consuming for large projects. Plywood formwork material has a short lifespan. Timber Shuttering is low-cost and easily workable shuttering. It can be cut and joined in any shape and size.

- **Steel Formwork:** Steel formwork is one become more popular due to its strength, durability, and repetitive reuse for a long period. Steel formwork is costly for small work but can be used for a large number of projects. Steel shuttering offers a smooth surface finish to concrete compared to timber formwork. It can be used for circular or curved structures such as tanks, columns, chimneys, sewers, tunnels, and retaining walls.

- **Aluminum Formwork:** As we know the density of aluminum is less than compare to steel and that makes it light weighted than steel. This is the main advantage when compared to steel. Aluminum formwork is almost the same as the formwork made from steel. Shuttering down with aluminum form is proven economical if large numbers of repeating usage are made in construction. Its major drawback is that no alteration is possible once the formwork is constructed.

- **Fabric Formwork:** With the advancement and new technology trends in building planning and designing, the construction of complex–shaped structural members is increased. To satisfy this need the fabric formwork is introduced which made of the flexibility of this material make it possible to produce concrete in any shape. The flexibility of fabric formwork makes it possible to produce concrete members of any shape.

- **Plastic Formwork:** Plastic formworks are lightly weighted, interlocking systems and can be used more than 100 times. It can be used for normal concrete construction. This type of formwork is now becoming popular for similar shapes and large housing schemes.

17.0 FABRICATION AND ERECTION

- Fabrication and manufacturing are industrial terms linked to the process of production or construction. Often, the two processes are confused, yet they are very different from each other. This article explores the meaning of both fabrication and manufacturing in industrial processes.
- This is achieved with computer-aided designs (CAD) that are often programmed using computer numerical control (CNC) technology which communicates directly with machinery on the factory floor.

Common Methods or Types of Fabrication

- **Cutting:** The cutting of a metal workpiece is a common fabrication technique in which the material is split or cut into smaller sections. Cutting can be used as a first step in a much larger fabrication process or the only step necessary in the process. Today's methods include laser cutting, waterjet cutting, power scissors, and plasma arc cutting.
- **Forming:** In manufacturing, forming is a fabrication process that bends or distorts metal to produce parts and components. Strips or sheets of metal are continuously fed through parallel rollers that shape the workpiece into the desired form.
- **Punching:** Punch presses are mechanical devices or machines used to punch or create holes in metals. Punching, as a fabrication process, has a two-fold purpose. The result "punches" or creates uniquely designed holes in the metal. The finished product can either be the removed uniquely shaped pieces that were punched out from the metal, known as blanks, or the holes can be used for fastening purposes.
- **Shearing:** Used to trim or remove unwanted material from metal material, shearing is achieved by mounting two blades above and beneath the metal to produce one long, straight cut. The process is primarily used to cut smaller lengths and differently shaped materials, the blades can be mounted at angles to reduce the necessary shearing force required.
- **Stamping:** Similar to punching, stamping creates an indentation rather than a hole during fabrication. The turret presses against the metal forcing the die to stamp shapes, letters, or images into the metal workpiece. Stamping machines can also cast, punch, cut, and shape metal sheets to create a wide range of products. Operations such as metal coining, blanking, and four slide forming are all performed with stamping machines.
- **Welding:** One of the more common fabrication processes, welding is the art of joining two or more pieces of metal together utilizing a combination of heat and pressure. Metals can vary in shape or size. The three main types of welding procedures are Stick or Arc Welding, MIG Welding, and TIG Welding.

UNIT-II

MECHANIZED CONSTRUCTION

1.0 INTRODUCTION

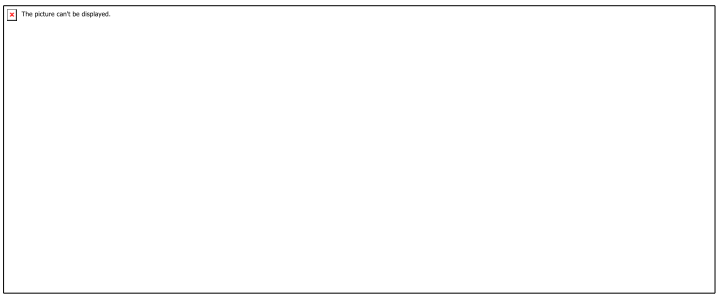
- Mechanization is the process of shifting from working largely or exclusively by hand to do that work using machines. The construction projects are becoming more demanding and complicated in construction and delay of projects would arise if conventional construction method is used.
- Construction machineries are used in order to achieve larger output, cost-effective, execution of work that is not feasible by manual efforts, reduce the amount of heavy manual work which would cause fatigue, maintaining large output, and finalize projects on time.

Applications of Construction Mechanization

- Highway projects
- Irrigation
- Buildings
- Power plant and other applications

Sources of Construction Mechanization

- The source of equipment from which construction equipment can be selected and obtained.



Advantages of Construction Mechanization

- Economical
- Improve construction quality
- Increase safety of construction conditions
- Enhance speed of construction
- Feasibility

Disadvantages of Construction Mechanization

- **Loss of Skill:** The craftsman with the superior skill had disappeared. Such skill is no longer necessary. The only type of skill that is needed now is to run the machines.
- **Dependence:** Machinery has increased our dependence on others. We depend for our water and light on the satisfactory working of water-works and the power-house. A small flaw would result in the supply of these necessaries being cut off at any time.
- **Insanitary Surroundings:** Big factories pollute their surroundings and make them filthy and insanitary. This has led to moral degradation and physical deterioration.
- **Over-specialization:** Machinery leads to too much specialization. This over- specialization increases the risk of unemployment and cramps the worker physically.
- **Class-conflict:** Use of machinery is responsible for class-conflict the capitalist on one side and the laborer on the other.
- **Unemployment:** It creates unemployment because one machine can take the place of several men.

2.0 CONSTRUCTION EQUIPMENT

Use of the construction equipment for Mechanization in Construction

- The cost of construction is a major factor in all projects, therefore there are many factors influencing the construction costs such as labor, material, construction equipment, profit etc. costs of construction equipment ranges from 25% to 40% of total project cost.
- Deployment of construction equipment is done for the reasons as mentioned below: larger output, Cost-effective implementation
- For execution of work that is not feasible by manual efforts or when deployment of construction equipment may help in doing the work more cost efficiently.

Selection of equipment for Mechanization in Construction

- Selecting the appropriate equipment for the job ideally forms part of the construction planning process and should be chosen for performing any particular task only after analysis of many interrelated factors.
- The important points for consideration are: Function to be performed, Capacity of the equipment, Method of operation, Limitations of the method, Costs of the method, Cost comparison with other methods, Possible modification.

Need of mechanization for the construction industry

- The work can be done speedily.
- The work can be done in time.
- Large quantity of materials can be handled.
- The complex projects involving high grade material.
- High quality standards can be maintained.
- Time schedule can be kept.
- Optimum use of material, manpower and finance.

3.0 CONCEPT OF EQUIPMENT ECONOMICS

- Once the strategy of implementation is finalized and construction equipment and machineries are selected every executing agency has the clear option of purchasing or renting or a combination of partly purchasing and partly renting the selected construction equipment or machineries.
- The owners may also purchase and rent out the same to the executing agencies for the sake of progress of implementation.
- For an executing agency, purchasing of construction equipment and machineries would be advantages for the reasons as follows: Construction equipment and machineries would be available at all times for deployment, Cost of such resources could be apportioned (divided) among different contracts.
- However, renting of construction equipment and machineries would be advantageous for the reasons as follows: Construction equipment and machineries could be rented when required for particular period of time, on completion of the hiring period, the executing agency would be liability – free of rental items.
- Equipment cost can be classified to: Ownership Cost Operating Cost Purchase expense (out flow) delivered cost (options, shipping, taxes, less cost of tires) it's fixed asset.
  Major repairs: - It is repair to extension of machine's services life. Taxes up to 4.5 % of assessed machine value (property taxes) percentage of book value of machine. Insurance; (1-3) % of book value or AAI (fire, damage) Storage (0-5) % (include spare rental, utilities wage of laborers and watch them) Taxes, insurance and storage = rate (%) × B.V. (or A.A.I) portion of ownership.

4.0 EXCAVATORS

- An excavator is a must on your job site when you need to lift heavy amounts of soil. Excavators are popular earthmoving vehicles that feature a bucket, arm, rotating cab and movable tracks.

- These components provide superior digging power and mobility, allowing this heavy equipment to perform a variety of functions, from digging trenches and breaking holes to lifting away waste and excavating mines.

Types of Excavators

1. Crawler Excavators

- Unlike other large excavators that run on wheels, crawlers run on two large endless tracks and are optimal for mining and heavy-duty construction jobs. Also known as compact excavators, these excavators use hydraulic power mechanisms to lift heavy debris and soil.
- Their chain wheel system allows them to slide down and scale hills with less risk, making them suitable for grading hilly areas and landscaping uneven terrain. While slower than other excavators, crawlers provide greater balance, flexibility and stability overall.

2. Wheeled Excavators

- Wheeled excavators are similar in size and appearance to crawlers but run-on wheels instead of tracks. Replacing tracks with wheels makes them faster and easier to maneuver on concrete, asphalt and other flat surfaces while still offering the same power capabilities.
- However, operators can add outriggers to increase stability when transitioning between asphalt or concrete and an uneven surface.

3. Dragline Excavators

- The dragline excavator is a larger excavator that operates with a different process. The equipment utilizes a hoist rope system that attaches to a bucket via a hoist coupler. The other side of the bucket affixes to a dragline that runs from the bucket to the cab. The hoist rope raises and lowers the bucket while the dragline pulls the bucket toward the driver.
- Due to their weight, draglines are often assembled on-site. The unique system of this type of excavator is commonly used in large-scale civil engineering projects like canal dreading.

4. Suction Excavators

- Also known as vacuum excavators, suction excavators feature a suction pipe capable of providing up to 400 horsepower. The excavator first releases a water jet to loosen the ground.
- The pipe, which contains sharp teeth at the edge, then creates a vacuum that carries away soil and debris up to 200 miles per hour.
- A suction excavator is ideal for delicate underground applications, as it can reduce the chance of damage by more than 50 percent.

5. Skid Steer Excavators

- Unlike standard excavators, skid steers have booms and buckets that face away from the driver. Making these excavators useful in more narrow areas and maneuvering tricky turns.
- They are often used for digging pools, site cleaning, residential work and debris removal, where space is more limited and objects are spread far apart.

6. Long Reach Excavators

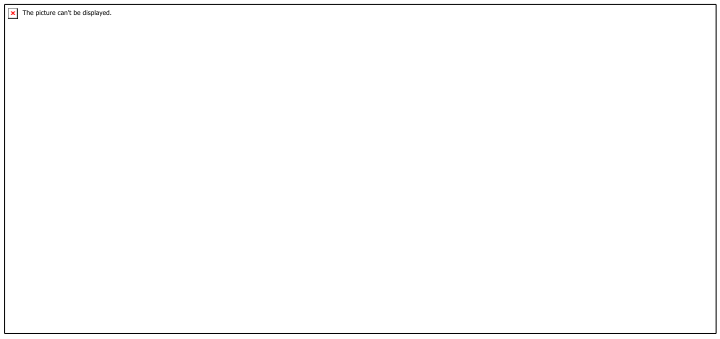
- The design allows for better operation in hard-to-reach locations. The excavator's extendable arm can reach over 100 feet horizontally. These excavators are best used for demolition projects like structural crumpling and breaking down walls over bodies of water. Different attachments can be affixed to the arm to perform additional jobs such as shearing, crushing and cutting.

7. Mini Excavators

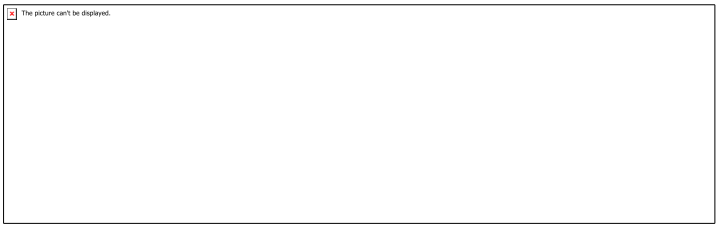
- In recent years, more contractors are using mini excavators, a smaller and lighter version of the standard excavator capable of minimizing ground damage and fitting through crowded, narrow sites like parking lots and indoor spaces. Also known as compact excavators, mini excavators typically

- incorporate reduced tail-swing or zero tail-swing to maneuver tighter turns and avoid contact with any obstacles.

Excavator Attachments and Parts



- Excavators use a variety of hydraulic attachments that serve different purposes. In addition to a bucket, other common attachments include an auger, breaker, clamp and quick coupler.



- **Bucket:** Buckets are the most common attachments seen on excavators. These steel attachments have teeth-like edges that can provide digging and scooping capabilities.
- **Auger:** Attaching an auger allows you to bore into the ground. Powered by hydraulic circuits, these helical attachments can reach over objects and drill deep holes. Augers come in different specifications and sizes for various digging conditions and terrains — they range from 4 inches to 50 inches in length and can dig up to 32 feet.
- **Breaker:** Breakers are similar to jackhammers but are much larger in size. With the ability to provide up to 1,000 pounds of impact energy, these attachments can break into tougher surfaces like stone and concrete.
- **Clamp:** Clamps allow excavator operators to pick up large materials that are too oversized for a bucket, such as tree stumps and concrete. The attachments can be used with buckets or as pieces in a grapple.
- **Coupler:** Couplers allow you to quickly switch between tools and attachments without a crew. Their versatility is handy when moving between different tasks and processes on a job site.

5.0 COMPACTION EQUIPMENT(ROLLERS)

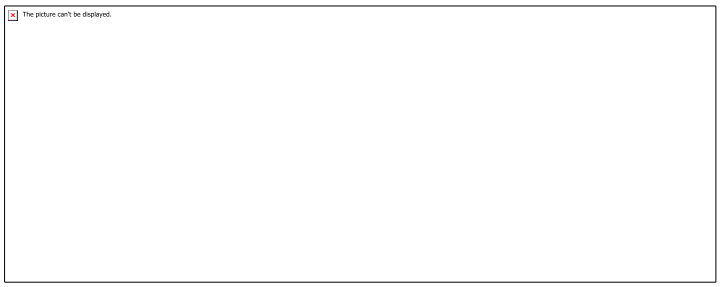
The reason for compaction is to improve soil properties to:

- Reduce or prevent settlement
- Increase strength.
- Improved bearing capacity
- Control volume changes
- Lower permeability

TYPES OF ROLLERS

The various types of rollers which are used for compaction are:

1. CYLINDRICAL ROLLER

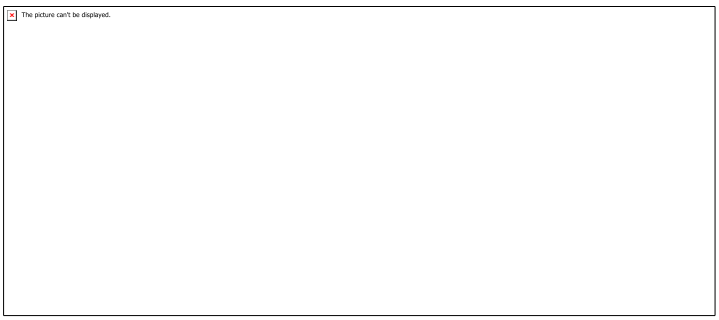


- This is a light roller of iron, concrete or stone; drawn by hand or bullocks. The size varies, but it is generally about 1 meter in dia. and about 1.5 meter long.
- This ground pressure generated by this type of roller is about 7 kg/cm2.

2. SHEEPSFOOT ROLLER

- This type of roller consists of a drum having many round or rectangular shaped protrusions or “feet” on it. These rollers are also called tamping rollers.
- The most common type is the one having two drums 1.22 meters wide and 1.06 either as taper-foot or club-foot rollers according to the shape of the feet.
- Area of each protrusion can vary from 30 to 80 cm2. The coverage area is about 8 to 12%.
- The thickness of compacting layer is kept about 5 cm more than the length of each foot.
- This type of roller mostly used for compaction of cohesive soils such as heavy clays and silty clays. Not effective with sandy soils.
- The soil is supposed to be consolidated when the impression by the projecting teeth is not more than 12 mm deep or when the surface has been rolled 16 to 20 times.
- The density of the consolidated soil should be about 1.48 kg/cm3. The top layer has to be finished with a smooth wheel roller.

3. PNEUMATIC TYRED ROLLERS



- This type of roller consists of a heavily loaded wagon with several rows of four to six closely spaced tires. This is also called rubber-tired roller. It provided uniform pressure throughout the width.
- Tire pressure may be up to about 7 kg/cm2, the coverage area is about 80%.

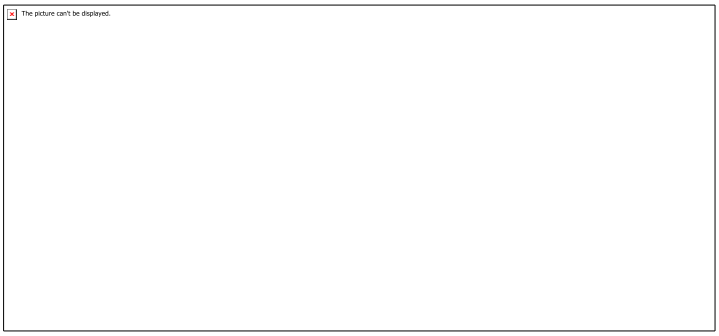
- The gross weight of the roller is about 6 to 10 tones which can be increased to 25 tones by ballasting with steel section or other means.
- The maximum density can be achieved by 8 passes of the roller. The optimum speed of roller is between 6 to 24 km/h.
- These rollers are also suitable for compacting closely graded sands, and fine-grained cohesive soils at moisture content approaching their plastic limits, though the compaction is not as high as that with the smooth wheel roller.

4. SMOOTH WHEELED ROLLER

Single Drum or Three-wheeled **Double Drum or Tander**

- This type of roller consists of a large steel drum in front and one or two wheels or drum on the rear end.
- The weight of tandem roller varies from 2 to 8 tones and that of two wheeled roller varies from 8 to 10 tones.
- It ground coverage provided by smooth wheeled roller is 100%.
- The weight of the roller can be increased by filling the inside space of the drum with water or wet sand. This is called ballasting.
- The ground pressure exerted by tandem rollers is about 10 to 17 kg/cm2.
- The optimum working speed has found to be 3 to 6 km/h and about 8 passes are adequate for compacting 20 cm layer.
- Scrappers are provided on all the wheels in adjustable positions covering the full width of the roll, with water sprinkling arrangement, for scraping of the mud and keeping the wheels clean during rolling.
- The maximum grade a road roller can climb is 1 in 5.

5. VIBRATORY ROLLERS



- This type of roller is fitted with one or two smooth surfaced steel wheels 0.9 m to 1.5 m in diameter and 1.2 m to 1.8 m wide.
- Self-propelled vibratory rollers are now available weighing from 4 to 6 tones.
- Vibrations are generated by the rotation of an eccentric shaft inside.
- A vibratory roller is used for compacting granular base courses. It is sometimes used for asphaltic concrete work.

6. GRID ROLLERS

- These rollers have a cylindrical heavy steel surface consisting of a network of steel bars forming a grid with squire holes and may be ballasted with concrete blocks.
- They are generally towed units and can operate at speeds between 5 and 24 km/h.
- Typical weights vary between 5 tones net and 15 tones ballasted.
- Grid rollers provide high contact pressure but little kneading action and are suitable for compacting most coarse-grained soils.

6.0 BULLDOZERS

- Bulldozers are strong machines that mainly assist with pushing, digging, excavating, and leveling materials like soil and debris at a work site.
- They come with large, heavy blades in the front that push material. Some come with other modifications like rippers in the rear to help break down tough ground.

Types of Bulldozers

- There are many different bulldozer types to choose from depending on your specific project. The type of terrain you're working on, your project type, and other criteria are key factors to consider when selecting a bulldozer.
- The right machine is also crucial for both the efficiency and safety of your project.

1. Crawler Bulldozer

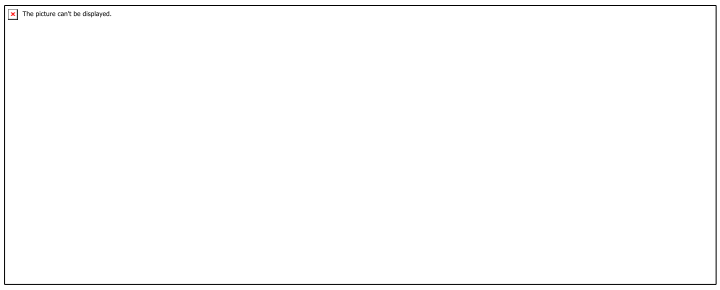
- A crawler is sometimes referred to as a track bulldozer and looks most similar to a tractor. This heavyweight is great for moving heavy materials from one area to another.

- This bulldozer is ideal for traversing dense and irregular terrain since the tracks give it great traction. Larger crawlers have rippers that assist with crushing and clearing dense terrain.

2. Wheel Bulldozer

- This machine is sometimes referred to as a tire bulldozer and is normally larger than a crawler. A wheel dozer is more maneuverable than a crawler since its tires offer better overall handling.
- It also has completely articulated hydraulic steering and moves on a smaller axis. This machine is also ideal to use for soft or sensitive ground since the tires are gentler than tracks.

3. Mini Bulldozer



- This smaller bulldozer is also known as a compact bulldozer. A mini dozer is great for projects that require more maneuverability and versatility than larger machinery. Thanks to its small size, a compact bulldozer can perform well in different types of projects that require tasks like grading and clearing lots.

Types of Bulldozer Blades

- Different blades serve different purposes, can handle different types of materials and can handle a range of load weights. We listed the most common types below.

1. Straight Blades (S-Blade)

- An S-blade is the shortest type of blade a dozer can use and does not have side wings. This blade attaches to the arm in the lower back corners of the blade. Thanks to its shape, the straight blade is best for fine-grained and medium- to hard-density materials. Some of the best tasks for s-blades include stumping, back-filling, grading and evening soil.

2. Universal Blade (U-Blade)

- A U-blade has large side wings and a curved shape that makes it ideal for pushing materials across long stretches of land. The wings keep material from spilling over when in motion. Like S-Blades, they also attach to the lower back corners of the blade. It's the largest blade type in both height and width and is best used with soft- to medium-density soil. Some of the best tasks for u-blades include ditching, hauling, pushing and crowning.

3. S-U (Semi-U) Blade

- This blade combines features from the S-blade and the U-blade to give it stronger penetration and better overall versatility. It's narrower, less curved, and its side wings are smaller compared to a normal U-blade.
- This blade attaches in the lower back of the blade using angled stabilizing braces and either one or two hydraulic tilt cylinders. Some of the best tasks for an s-u blade include crowning, moving heavy material, stumping and ditching.

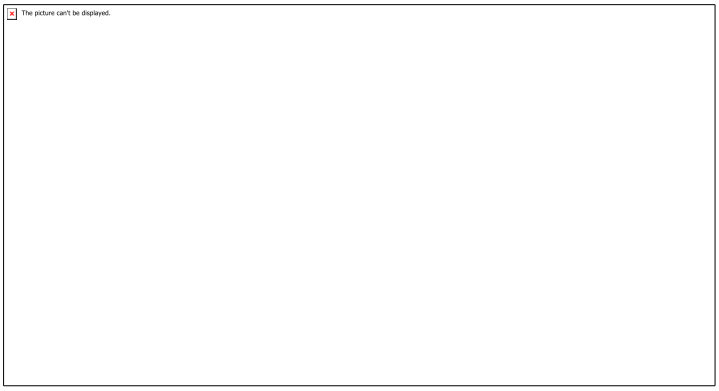
4. Angle Blade

- This type of blade attaches to the center of the bulldozer's panel. Its location is useful for moving debris to the side since it can angle close to 30 degrees left or right.
- Due to this, an angle blade is considered a two-way blade. Keep in mind that this blade can spill since it does not have side wings. Some of the best tasks for angle blades include stumping, shaping, stripping and ditching.

5. Power-Angle-Tilt (PAT) Blade

- The PAT blade is one of the most versatile blades thanks to its easy maneuvering and multifaceted motions. The driver controls the blade from the cabin and can angle, tilt, and lift in almost all directions.
- Some of the best tasks for PAT blades include scraping, land clearing, leveling, backfilling and grading.

Bulldozer Parts and Functions



- **Rippers:** Rippers are used to break up land to allow agriculture to grow or break down rock and earth to be moved. You can find both single-shank rippers and multi-shank rippers depending on your project needs.
- **Final Drive:** A bulldozer's final drive are likely the most used and most replaced part on a bulldozer. Modern final drives distribute the load over multiple gear teeth and lifts the drive motor away from suspension.
- **Cab:** The bulldozer's cab is an important part of this machine since it's where the operator controls this machine. There are different features for some cabs that increases both its level of comfort and safety.
- **Tracks/Tires:** Tracks and tires greatly impact a bulldozer's mobility. Tracks are great for navigating hard, uneven terrain while tires are better suited for soft ground.
- **Engine:** Bulldozers generally require high-powered engines since they move lots of heavy materials around the work site. There are different types of engines that fulfill different needs.
- **Push Frame:** The push frame is essential when positioning materials for different tasks. This bulldozer part is responsible for moving the blade.
- **Bulldozer Blades:** The blade is the heavy metal plate located at the front of the bulldozer that is used to push and dig through materials.

7.0 SCRAPPERS

- Scraper machines are used to remove layers of earth across a vast area of land. When the scraper machine and it's attached trailer pass over an area of dirt to be removed, the operator drops a sharp horizontal blade located in the trailer, or otherwise known as the bowl, into the soil below.
- Scraper machines are used for earth moving in construction, mining and agriculture industries and often is the plant hire machine of choice over vast areas and on leveling projects.

Types of Scrapers

- **Single Engine Wheeled Scraper Machine:** The Single engine wheeled scraper machine is probably the most common machine found on construction sites across the country. It consists of a bowl and an apron which covers the load and stops it from flying out the top. The bowl also features hydraulic lifters that enable the bowl to be dumped and emptied at another location.
- **Dual Engine Wheeled Scraper Machine:** For terrains that are a little tougher than your average job site, the dual engine wheeled scraper machine would be required. This scraper machine includes a powerful engine, not only in the front-end vehicle itself, but also in the trailer. This extra power capacity enables earthmoving work with the scraper machine to be carried out on terrain that is less than ideal.
- **Elevating Scraper Machine:** If you need a machine that not only removes dirt and soil but also mixes, homogenizes and completes fine finished work, then the elevating scraper is what you are looking for. Elevating scraper machines are better suited to fine soils such as fine clay, top soil, sand and other fine materials. When the scraper machine is passed along a stretch of soil, the conveyor belts turn up the dirt

- into the bowl which is also stirred at the same time, homogenizing the material as the machines continues its work.
- **Pull Type Scraper Machine:** Pull type scrapers are just as the name suggests, an unpowered trailer that needs to be fitted to a tractor in order to be propelled. This type of scraper machine does not have an engine, therefore needs to be pulled by another vehicle that is big enough to withstand its size.

8.0 CONCRETE EQUIPMENTS

- Concreting Equipment is significant for construction companies.
- It can hence eliminate its work expenses and increment benefits by giving the quality construction service to its customers in a quicker manner. With the headway in advancements, today various construction equipment types of gear have come up for the utilization of construction companies for improved construction processes.

1. Concrete Batching Plant

- A concrete batching plant is a significant gear for the concreting equipment. The concrete batching plant utilized for the is created by the appropriate blending of the considerable number of fixings like sand, rock, water, and cement and after that moved to concert building site prepared to be poured for use.
- Concrete batching plants can be of two structures either the stationary heavy production units or the well-known mobile batching plants which can be utilized to both produce and transport the solid blend from site to site.
- Since today group plants are accessible in different generation limits as well. 20 cum/hr. batching plant, 30 cum/hr. concrete plant, 45 cum/hr., 60 cum/hr., 90 cum/hr., 120 cum/hr.

2. Concrete Mixer

- A concrete mixer is the best source for the construction that wants to save their precious raw material from waste that cannot be tolerated. Mixers used to mix all the elements like cement, gravel, and water for better mixing and it also saves time because of its high efficiency while they working.
- There are too many varieties available in concrete mixers like Self-loading concrete mixer, Transit mixer that mounted on a truck, Stationary concrete mixer, Electric Concrete Mixer, Concrete mixer enables with lift, reversible concrete mixer is the types of Concrete mixer.

3. Concrete Vibrator

- Concrete vibratory is the mechanical device used to create vibration in wet material. This machinery alien with the motor and connected with pipes that create the vibration inside the concrete mix. And remove the all air in between the concrete mix. So gives more strength and life to concrete.

4. Concrete paver

- Concrete paver has advanced the construction technology by securing the concrete from unexpected wastage. Paver is a kind of moveable construction machine that consists of a paving area used to store the material while working on busy roads, highways, and other public places where traffic or pedestrians can cause the deficiencies while they working.

5. Concrete Tank

- Concrete tanks are used to save both labor and machine costs because they need to be built of construction sites and installed on the peak- positions. Tanks are usually made of concrete, have pipes at the bottom as the exit of material to the site. Basically, the tank is used to make concrete material by pouring water, cement, and gravels in it.

6. Concrete Crusher

- Concrete crushers have two types: One is a mobile concrete crusher similar to a bulldozer but has an attachment with its boom arm use to crush the big rock pieces into small gravels. The second type mostly can be seen in the industrial used for crushing medium-sized rocked into power or gravels form. Concrete crushers are the best source for saving labor costs and time.

7. Concrete Conveyor

- A concrete conveyor system is usually to use a mobilized construction site. They are based on a conveyor belt by which transfers the gravels, cement, and other concrete material directly on the mixer and they are also used for filtration of Concrete material.

8. Concrete Boom Placer

- Boom Placer is one of the most used concrete machineries used in the construction of the site. Many construction sites don't have such facilities that other mixers or men can reach and concrete mix can pour at the site.
- Where Boom placer comes in the picture it can do the concrete from 36 meters to 100-meter distance far away. If your site in an underground or heightened location than a concrete boom placer machine will be much benefitted to you.

9.0 HANDLING EQUIPMENTS

1. CRANES

- To understand a crane's movement, it's helpful to have a good grasp of the various parts that make up a construction crane.
- When looking at a crane, you can identify all of the parts easily by starting at the base of the crane and working your way up, then running your eyes along the length of the crane from the long end to the short end.

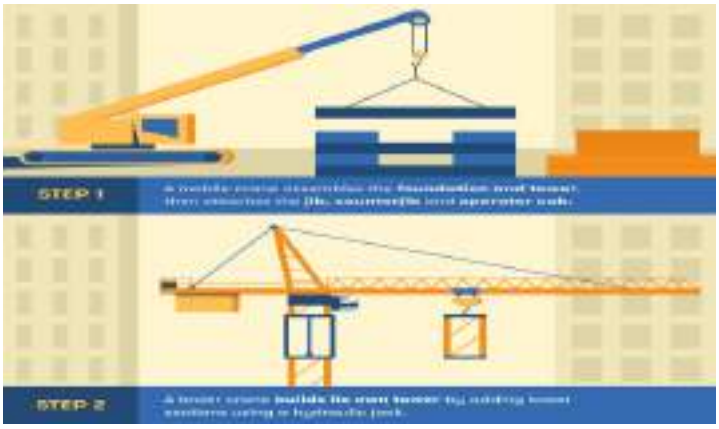
Parts of a Crane

- **Concrete foundation:** A tower crane always sits on a concrete foundation, where anchors are placed to secure the crane to the ground.
- **Tower or mast:** From its base, the crane rises up with the tower, also called the mast, which consists of lattice sections stacked on top of one another.
- **Turntable:** At the top of the tower, the crane has a turntable that enables it to rotate 360 degrees.
- **Operator's cab:** Near the turntable, the operator's cab gives the crane operator a place to control the crane with an unobstructed view.
- **Jib:** Stretching out forward from the cab is the jib, the long horizontal section of a crane.
- **Trolley and hook block:** Along the jib, a trolley with a hook block runs back and forth, enabling loads to be moved along the length of the crane.

- **Counterjab and counterweights:** Behind the cab is the counterjab, where counterweights are placed to stabilize the crane at rest and during movement.
- **Main winch and motors:** At the back of the counterjab sits the main winch and motors, which enables the long rope to be lowered or raised to hoist heavy loads.
- **Tower peak or apex:** Rising above the cab is the tower peak, also known as the apex, where the pendants extend out to support the jib and counterjab.

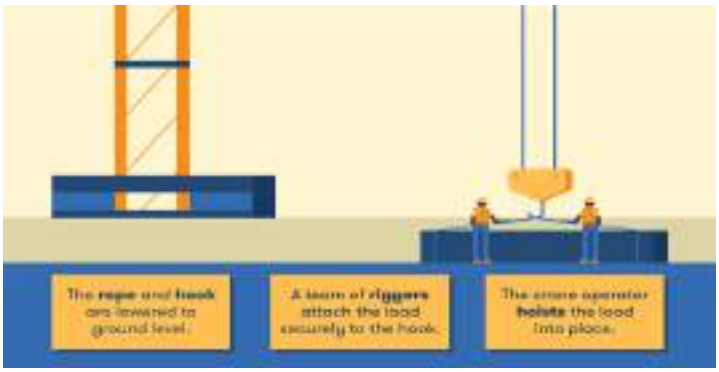
How Cranes Are Built

- A concrete foundation is prepared so that the crane will be safely anchored to the ground and stable during lifting.
- A mobile crane assembles the tower crane, lifting several segments of tower into place along with core components.
- The tower crane builds the rest of its own structure as it rises to its ultimate height.



How a Tower Crane Performs Lifts

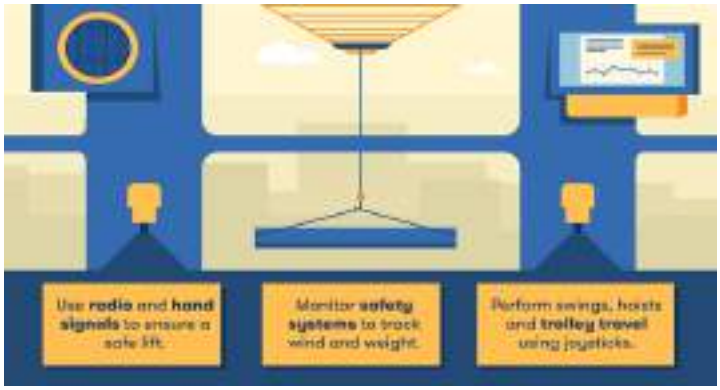
- A tower crane will perform hundreds of lifts over the course of a construction project, moving heavy materials like steel and concrete into place for construction workers assembling a building.



- The rope is lowered down along with the hook so that the load can be attached.
- A crew of riggers securely attach the load to the hook, following basic principles of physics to ensure a stable lift.
- The crane operator performs a series of moves, including hoists, which raise the load with the rope, rotations, which spin the crane, and trolley travel, which moves the load along the jib.

What a Crane Operator Does

- Crane operators sit inside the cab and use controls to maneuver the crane. Each day, a crane operator must climb a ladder inside the tower — sometimes hundreds of feet — to get to the cab and start work for the day. Importantly, a crane operator must always perform daily safety checks before starting operations.

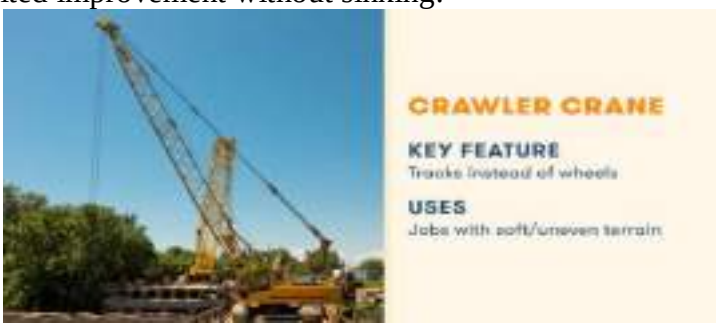


- Communicate with radio and hand signals to ensure a safe lift.
- Monitor computer safety systems that keep track of wind speed and weight capacity limits.
- Use joysticks to perform crane maneuvers like swings, hoists and trolley travel.

Types of Cranes Commonly Used in Construction

- **Carry Deck Crane:** Carry deck cranes are a relatively new type of crane that evolved from the older pick and carry model that was first introduced in the 1980s. They're small, four-wheeled, can rotate a full 360 degrees, and are more portable than other types of cranes.

- **Crawler Crane:** Instead of wheels, crawlers are built on an undercarriage fitted with a pair of rubber tracks. Though this limits the crawler's turning capacity, the tracks make it possible to use on soft ground and sites with limited improvement without sinking.



- **Floating Crane:** Also known as a crane vessel or crane ship, these floating cranes are used for projects at sea, such as ports or oil rigs. As of today, there are several types of floating cranes as well, such as the sheerleg and semi-submersible.

- **Truck-mounted Crane:** Truck-mounted cranes are made up of two parts: the carrier (truck), and the boom (arm). Due to their unique build, they're able to travel easily on the road with no unique set up or

- transportation equipment. Truck-mounted cranes are outfitted with counterweights and outriggers for stabilization, allowing them to move slowly while carrying a large load.

- **Bridge/Overhead Crane:** The bridge crane, also known as an overhead crane, are typically found in industrial environments. Its name comes from the fact that it resembles a bridge supported by two steel beams that straddle the workload, with the hoist (lifting mechanism) traveling along the bridge part of the crane.

- **Hammerhead Crane:** Hammerhead cranes are some of the most commonly used in construction projects. This crane has a horizontal, swiveling lever resting on a fixed tower. The trolley is held in the forward part of the arm and is counterbalanced with the part of the arm that extends backward.
- Hammerhead cranes also offer a feature known as racking, which allows the trolley to move forward and back horizontally along the crane arm. These cranes can be extremely heavy and are assembled on the job site.

- **Stacker Crane:** Stacker cranes are automated machines with a forklift-like mechanism and are primarily designed for warehouse storage. Typically, stacker cranes are used in places with special working conditions, like extremely cold temperatures, making it unnecessary for a human worker to endure extreme working conditions.

- **Tower Crane:** Commonly used in the construction of tall buildings, tower cranes are beautiful machines that offer amazing lifting capabilities. Due to their size, tower cranes are equipped with an

- operating cab that controls the entire crane. Tower cranes have their jib extending horizontally from the mast (tower part), which itself rests on a concrete base.
- A luffing jib is able to move up and down, while the fixed jib has an operating dolly that moves materials horizontally. The engine (called a slewing unit) that controls the rotation of the crane sits on the top of the mast.

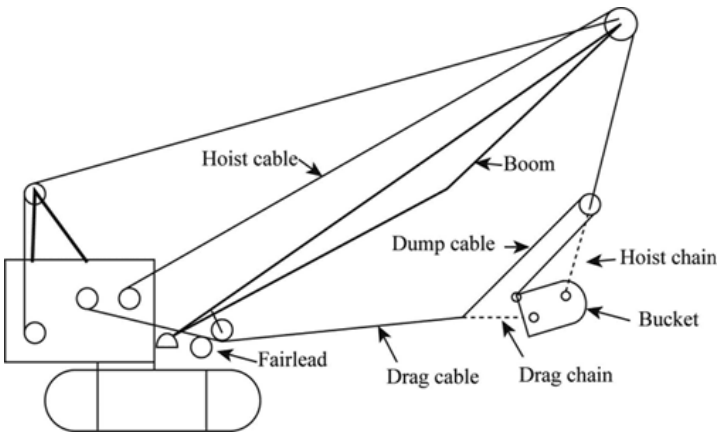
10.0 DRAGLINES

- Draglines are used to excavate material and to load it into material and to load it into hauling units, such as trucks or hauling units, such as trucks or tractor--pulled wagons, or to pulled wagons, or to deposit it in levees, dams, and spoil banks near the pits from which it is excavated.
- It operates adjacent to the pit while excavating material from the pit by casting its bucket. This is very advantageous when earth is removed from a ditch, canal, or pit containing water.

Types of Draglines

- **Crawler mounted:** A crawler-mounted dragline can operate on surfaces that are too soft from the wheel and truck-mounted dragline. The speed of crawler mounted dragline is as low as 2 kmph.
- **Wheel-mounted:** Whereas the wheel or truck-mounted dragline has the advantages of mobility.
- **Truck-mounted:** The wheel or truck-mounted dragline can travel as high as 50 kmph.

Basic components of dragline



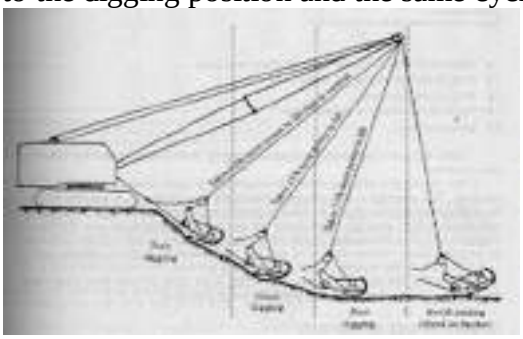
Principle of Dragline

- Dragline drops the bucket on the source and then drag it horizontally bucket start tilting as it come closer to the machine. Uses of Dragline, Deep down pile driving, Surface mining, Deep down excavation, Underwater excavation, Road excavation

Operation of dragline

- By releasing both the hoist and drag cable the bucket is lowered down in a fully dumped position till it rests on the ground with the sharp digging teeth into the earth. The hoist cable becomes active slightly and then the dragging pull is applied.

- This action fills in the earth and the bucket take a horizontal position. Then the bucket is pilled. The boom is swung to the position of dumping when the needed dumping height is achieved, and then the drag brake is released. This process will dump the load off the bucket.
- Then, the boom is swung back to the digging position and the same cycle of operations is repeated.



The size of a dragline

- The size of a dragline is indicated by the size of the bucket, expressed in cubic yards (cu yd). Most draglines may handle more than one size bucket, depending on the length of the boom utilized and the class and weight of the material excavated.
- Since the maximum lifting capacity of a dragline is limited by the force which will tilt the machine over, it is necessary to reduce the size of the bucket when a long boom is used or when the excavated material has a high unit weight.
- In practice, the combined weight of the bucket and its load should produce a tilting force that is not greater than 75% of the force required to tilt the machine.
- A longer boom, with a smaller bucket, will be used to increase the digging reach or the dumping radius when it is not desirable to bring in a larger machine.
- If the material is difficult to excavate, the use of a smaller bucket, which will reduce the digging resistance, may permit an increase in production.

11.0 CLAMSHELLS

- Clamshells are used to handle loose material such as sand, gravel, and crushed stone. They are especially suited for lifting material vertically.
- Clamshell buckets are available in various sizes, and in heavy duty types for digging, medium weight types for general purpose work and lightweight types for rehandling light materials.
- Manufacturers supply buckets either with removable teeth or without teeth. Teeth are used in digging the harder types of materials but are not required when a bucket is used for rehandling purposes.

Capacity of clamshell buckets

- The capacity of a clamshell bucket is usually given in cubic yards. A more accurate capacity is given as water level, plate line, or heaped measure, generally expressed in cubic feet.
- The water level capacity is the capacity of the bucket if it were hung level and filled with water. The plate line capacity indicates the capacity of the bucket following a line along the tops of the clams.
- The heaped capacity is the capacity of the bucket when it is filled to the maximum angle of repose for the given material. In specifying the heaped capacity, the angle of repose is usually 45º.

Production rates for clamshells

- Because of the variable factors which affect the operations of a clamshell, it is difficult to give dependable production rates.

The variable factors affecting operations include:

- The difficulty of loading the bucket
- The size load obtainable
- The height of lift
- The angle of swing
- The method of disposing of the load
- The experience of the operator

The cycle time of clamshell: Loading bucket, Lifting and swinging load, dumping load, Swinging back to the place of work, Acceleration-deceleration-braking time.

Concrete Equipments

Description	Purpose	Capacity	Remarks
Concrete batching and mixing plant concrete mixers	For weighing and mixing large quantity of concrete cons	20 m^3/h to 250 m^3/h	Comes in different varieties such as stationary and mobile batching plants
Concrete mixers	For mixing small quantities of concrete constituents	Capacity could be up to 200 per batch for small mixers, and between 200 & 750 per batch for large mixers	Non-tilting drum type and tilting drum type
Concrete transit mixers	For transporting concrete from batching plant	3 m^3 to 9 m^3	Capacity also depends on the permissible axle load
Concrete pumps, static or portable	For horizontal & vertical transportation of large volumes of concrete in short duration	30 m^3/h for ordinary construction; can be in excess of 120 m^3/h for specialized construction	Direct acting pumps- an output up to 60 m^3/h through 220 mm delivery pipes. Concrete can be easily pumped up to distance of 450 m horizontally or 50 m vertically squeeze pumps – an output of up to 20 m^3/h through 75 mm delivery pipes. Concrete can be easily pumped up to a distance of 90 m horizontally or 30 m vertically.

Earthwork Equipments - Overview

Description	Purpose	Application	Remarks	Capacity
Backhoe	For excavation below the ground	Cutting of trenches, pits etc., levelling & loading.	Suitable for heavy positive cutting	Struck bucket capacity 0.38 m^3 to 3.25 m^3
Shovel or front shovel	For excavation above its own track or wheel level	For cutting & for loading	Suitable for heavy positive cutting in all types of soils	Struck bucket capacity 0.38m^3 to 3.25 m^3
Drag line	For bulk excavation in loose soils its own track level	For canals & pits excavation, cutting & desilting of ditches	Suitable for loose soils, marshy land	0.38 m^3 to 3.06 m^3
Clamshell or grab	For deep confined cutting in pits, trenches	Such as shafts, pits, wells	Consists of a hydraulically controlled bucket suspended from a lifting arm	0.38 m^3 to 3.06 m^3
Dozers	For moving earth up to a distance of about 100m, shallow excavation and cutting tractors & pushers to scraper machines	Clearing and grubbing sites, excavation of surface earth.	Can be track-mounted or wheel mounted	Blade capacity 1.14 m^3 – 6.11 m^3

Roller compactor	For compaction of earth or other materials	Used for large words of highways & airports	types 1. smooth-wheel roller 2. vibratory roller 3. pneumatic roller 4. Sheep-foot roller	8-10 ft 4-17 ft 11-25 ft 2.5-11.5 ft
Scraper	For site stripping & levelling, loading & discharging over distances	Towed scrappers Two-axle scrappers Three-axle scrapers	Best suited for haul distances b/w 150m-900m	30 m^3 – 50 m^3
Dumper	For horizontal transportation of material on & off sites	Suitable for hauling on sub-grade, used in mines, quarries	Comes in different varieties side tipping or elevated tipping arrangement	1-80 t
Grader	For spreading fill and fine trimming the sub-grade. Grader performs a follow-up operation to scraping or bulldozing	Grading & finishing the upper surface of the earthen formations	Graders usually operate in the forward direction.	

UNIT-III

QUALITY CONTROL

1.0 QUALITY ASSURANCE AND QUALITY CONTROL

- Quality Control (QC) and Quality Assurance (QA) are crucial parts of the quality management of a construction project to have a quality product or service.
- Quality Control (QC) is interpreted as the process of detecting and correcting the problems when they occur, whereas Quality Assurance (QA) is the process of preventing problems from happening.
- In simpler words, QA is the process of planning to do the right things in the right way to achieve the desired quality at the end of the construction project.
- It is a system of routine technical activities, to measure and control the quality of the construction activities happening on the site. The QC system is designed to:
  A. Provide routine and consistent checks to ensure integrity, correctness, and completeness of the elements, material, or service.
  B. Identify and address errors and omissions
  C. Document and archive all QC activities or any defaults encountered along with its rectification process.

What is the difference between QA and QC in construction?

- Fundamentally, QA is focused on preventing defects and QC is focused on identifying the defects.
- Quality Assurance is about an arrangement. It is done before the actual construction begins. QA records the methods, principles, standards, and strategies that should be done and guarantees they are known to the individuals who need to know them.
- The key components of QC are observation and activity. In other words, QC is the investigation of the craftsmanship on a construction site. Quality Control verifies that the desired quality is met.

Difference between Quality Assurance and Quality Control

Quality Assurance (QA)	**Quality Control (QC)**
It is a procedure that focuses on providing assurance that quality requested will be achieved	It is a procedure that focuses on fulfilling the quality requested.
QA aims to prevent the defect	QC aims to identify and fix defects
It is a method to manage the quality- Verification	It is a method to verify the quality-Validation
It does not involve executing the program	It always involves executing a program
It's a Preventive technique	It's a Corrective technique
It's a Proactive measure	It's a Reactive measure
It is the procedure to create the deliverables	It is the procedure to verify that deliverables
QA involves in full software development life cycle	QC involves in full software testing life cycle
To meet the customer requirements, QA defines standards and methodologies	QC confirms that the standards are followed while working on the product
It is performed before Quality Control	It is performed only after QA activity is done
It is a Low-Level Activity; it can identify an error and mistakes which QC cannot	It is a High-Level Activity; it can identify an error that QA cannot
Its main motive is to prevent defects in the system. It is a less time-consuming activity	Its main motive is to identify defects or bugs in the system. It is a more time-consuming activity
QA ensures that everything is executed in the right way, and that is why it falls under verification activity	QC ensures that whatever we have done is as per the requirement, and that is why it falls under validation activity
It requires the involvement of the whole team	It requires the involvement of the Testing team

2.0 QUALITY ASSURANCE AND SAFETY

- Quality control and safety represent increasingly important concerns for project managers. This is because defects or failures in constructed facilities can result in the loss of very large costs. Even with minor defects, re-construction may be required and facility operations impaired.
- Sometimes, failures may cause personal injuries or fatalities. Accidents during the construction process can similarly result in personal injuries and large costs. Indirect costs of insurance, inspection and regulation are increasing rapidly due to these increased direct costs

Quality Concern in Building Constructions

- Most crucial decisions regarding the quality of a completed building are made during the design and planning stages rather than during construction.
- It is during these preliminary stages that component configurations, material specifications and functional performance are decided.
- For instance, unforeseen circumstances, incorrect design decisions or changes desired by an owner in the building function may require re-evaluation of design decisions during the course of construction.

Safety Concern in Building Constructions

- Safety during the construction project is also influenced in large part by decisions made during the planning and design process.
- Beyond these design decisions, safety largely depends upon education, vigilance and cooperation during the construction process.
- Construction is a relatively hazardous undertaking. There are significantly more injuries and lost workdays due to injuries or illnesses in construction than in virtually any other industry.

3.0 ISO-9000 QUALITY SYSTEMS

- The present development strategies throughout the world demands formal quality management system as a necessary attribute for any business.

- When talking about the history of evolution of quality management systems; a large number of national standards were developed as a part of quality assurance in 1970s in the area of manufacturing, military and in industries.

- To develop formal quality management systems in construction industry, quality assurance and related are registered with certified bodies. They seek third party certification based on the ISO 9000 quality standards.

- Among the ISO standards, the most relevant quality management system to be implemented in the case of a building professional is the ISO 9001. For contracting organizations, ISO 9002 is more relevant.

- **Management Responsibility:**A clear idea on the quality policy must be stated by the firm to the management. Well defined responsibilities and duties must be established on the staff members who are involved in the quality management. The continuing suitability and the effectiveness of the organization is ensured by having periodic review of the quality system of the firm.

- **Quality System:**The quality system practiced and to be practiced must be documented in the organization. This help in ensuring that the services are carried out properly and consistently.

- **Review of Contracts**: This must undergo periodic project reviews which help in having service that accord with the client's current contractual, administrative and the financial requirements. Pre-planning of the service is made which ensures the adequate resources and the support.

- **Control of Design:** Services to be provided are identified along with the identification of initial procurement and the advice for contract.The contractual and the financial administrative arrangements of the project are determined. For the performance and verification of services maintenance and the procedure for operating must be provided.
- **Other areas of concern will include are in the:**Every project must have a project plan specifying the number of staffs and the responsible performance for each activity. All internal and external data that are considered for the project developed is marked and documented as project data. Any change in the service design have to be identified and documented.
- **Control of Documents:**Identifying and monitoring the service with respect to status. The issuing and controlling will be done through approved persons. Prior to the issue, it will review for appropriateness. These quality documents can be issues and made available for the staff members who are involved the quality management system.
- **Purchasing**: In situations, necessary for special work requirements, a firm shall maintain a register of specialist firm. Based on which personnel can be appointed based on the ability to provide the required service. The documents relating to the subcontractors can have the details of such specialist firms.
- **Purchaser Supplied Product:**Details regarding the information given by the client, agents, and the consultants must be recorded by the firm. This includes the instructions, drawings, specification, minutes of meetings, schedules etc.
- **Process Control:** The firm must ensure that the activities that conforms to the quality is done based on the documented work procedures that is implemented by the firm. For special activities, continuous monitoring must be carried out.
- **Inspection and the testing:** This are dealt with the documents that are provided by the other organizations. These documents must be verified as per the client supplied information. The work carried out by the firm must be verified at predetermined stages of the project.
- **Inspection, measurement and equipment testing:** The inspection and the testing of the measuring equipment must be conducted in the sound condition. This must be done with utmost accuracy to ensure the quality in the service.
- **Status of Inspection and the test:** Inspection and the examination of the documents and the service that are provided must be done at every stage of the project.
- **Control of products that are non-conforming:** Those work that is non-conforming must be identified. Those document that does not comply with the requirements specifies have to be prevented.
- **Corrective action:** Wherever a deficiency is identified there must be certain procedures that have to be maintained by the firm to correct it. There must be a means to review any sort of non-conformance "feedback" system in the construction organization.
- **Handling, storing, packaging and the delivery:** The products that are outgoing must be properly addressed. They must show no chances to bring any damage.
- **Quality records:** Project information that will include all the project quality record that is meant to meet the requirements of the client.The records of administration of the quality system.
- **Internal quality system auditing:** The review of all the aspects of the quality system of the firm is done through periodic internal audits. This will show that the quality system is effectively used by the firm.
- **Training:** The firm must identify the need for training for the individuals who are working for quality working system. It is recommended that the professional staff must undertake a minimum training attendance for continuing professional development that is put forward by the firm. The details of the staff qualification, training, and their experience have to be recorded.
- **Servicing:** All the services provided by the firm to the client must be documented.
- **Statistical Techniques:** Random sample techniques can be carried out for the quality control and monitoring of the activities. The quality level can be determined early through the sampling frequency.

4.0 PRINCIPLES ON SAFETY

Principle 1: Demonstrate Safety Leadership

- Establish a project safety management framework
- Identify safety champions for appointment to the project safety leadership team
- Appoint a project safety leadership team
- Develop project safety charter
- Develop project safety master plan

Principle 2: Promote design for safety

- Include safe design requirements in design consultant contracts
- Select qualified designers
- Establish requirements for safety in design

Principle 3: Communicate safety information

- Communicate safety commitments to prospective stakeholders
- Communicate project safety risk information to relevant stakeholders

Principle 4: Manage safety risks

- Conduct risk analysis of project options
- Undertake technical feasibility studies of viable options
- Select preferred project option based on robust risk assessment
- Record safety information in a project risk register

Principle 5: Continuously improve safety performance

- Establish key performance indicators (KPIs) for safety

Principle 6: Entrench safety practices

- Continuously develop safety capabilities
- Develop long-term relationships within supply chain

- Construction is one of the areas of employment where hazardous conditions are part of the everyday working environment. The construction industry is prone to many hazards and accident can happen if safety is ignored.

- Construction materials, tools, machinery, and handling techniques all come with their own dangers. The main types of accidents which cause death or serious injury on construction sites include falls, incidents with site vehicles, collapsing materials and contact with overhead power lines.

Causes of Injuries in Construction

1. Transportation incidents
2. Exposure to harmful substances and environments
3. Falls from a height
4. Struck by a moving vehicle
5. Struck by moving/falling object
6. Trapped by something overturning/collapsing
7. Drowning/asphyxiation.

Benefits of Construction Safety training

- Identify legal obligations in workplace health & safety,
- Identify hazards in a construction site,

- Understand the Permit-to-Work system,
- Practice safety precautions when working with different hazards,
- Competent in wearing Personal Protective equipment (PPE),
- Respond in case of fire emergency,
- Understand and respond to all industrial safety signs,
- Working safely at height, in and around excavation, hot work,
- Knowing the rights and responsibilities of workers.

At the end of the course, participants will be able to:

- Recognize the common safety hazards at construction site,
- Know the preventive measures to be adopted,
- Confident in working at height,
- Understand the importance of observing safety signs and safe work procedures,
- Understand importance of PPE and its limitations,
- Know their rights and responsibilities.

Measures to Improve Safety in Construction Site

1. Changing facility designs, particular structures can be safer or more hazardous to construct.
2. Choice of technology can also be critical in determining the safety of a jobsite. Safeguards built into machinery can notify operators of problems or prevent injuries.
3. Materials and work process choices also influence the safety of construction.
4. Educating workers and managers in proper procedures and hazards can have a direct impact on jobsite safety.
5. Regular safety inspections and safety meetings have become standard practices on most job sites.
6. Pre-qualification of contractors and sub-contractors with regard to safety is another important avenue for safety improvement.
7. During the construction process itself, the most important safety related measures are to insure vigilance and cooperation on the part of managers, inspectors and workers.
8. Sets of standard practices are also important for instance hard hats, eye protection, hearing protection near loud equipment, ensuring safety shoes for workers, and providing first-aid supplies and trained personnel on site.

5.0 PERSONAL SAFETY

- **Personal protective equipment (PPE)**: These are supplied to all the personnel's working on site and even for the personal who are temporary visiting to the site Personal protective equipment (PPE) can be classified as:Minimum Personal protective equipment (PPE), Additional Personal protective equipment (PPE)
- **Hard Hat or Helmet:**Hard hat or helmet is issued to each and every personnel working on site. It has to be worn all times at job site.
- **Safety Glasses:**Safety glasses are required at construction site every time debris is filled in air due to activities on site.
- **Hand Protection Gloves:**Hand gloves are supplied to all personals to protect against cuts when handling material or equipment's, during cleaning operations, cutting metal studs or similar works.
- **Safety Vests:**Safety vests also called as high visibility shirts. Purpose of safety vest is to keep the person always clear in view, even in the dark and he should be visible to everyone. Safety vests are of different bright colours like red, green, yellow so it's easy for workers to see and locate each other
- **Proper Clothing:**Shirts, long pants and hard soul shoes, a 6-inch-high boot is recommended.
- **Hearing Protection:**It is compulsory to wear hearing protection equipment near any equipment, tool or machinery which makes loud noises. As per standard practice if you are 2 foot away from somebody and you need to shout to talk, putting hearing protection is necessary.

- **Respiratory Protection:**Sometimes as voluntary respiration policy dust mask is supplied, any employee looking for additional comfort or safety while working with fibre glass, fire proofing, cleaning the floors or handling debris.
- **Face shields:**A full face shield should be worn along with safety glasses when working in a high debris, operating grinder or any spark producing activity or similar activities or when done on site. An approved welding shield is compulsory to wear during all welding operations.
- **Safety Harness:**The safety harness is an attachment between a fixed and mobile object and is usually fabricated from rope, cable and locking hardware. Full body safety harness to be used as a procedure for fall protecting system, ignorance can result in severe physical harm. Safety harnesses keep workers safe and are helpful in freeing their hands for work even while hanging on the side of a building.

6.0 FIRE SAFETY

- Fire prevention must for that reason be a top main concern when planning and managing construction work. Construction sites are at an amplified hazard of fire owing to a range of factors.
- The presence of combustible waste materials, solvents, hot works processes and unfinished electrical systems. There is also amplified risk of destruction, trespass and malicious acts.
- The nature of the incomplete building and the storage of building materials on site which are often combustible surges the damage caused once a fire does take hold, and can also pose bigger risks to fire and rescue teams.
- The combination of hazardous activities, such as hot work, large quantities of fuel, flammable liquids, wood, liquefied gas (LPG), and potential issues with escape mean that construction sites pose a very real fire risk.
- A fire on a construction site not only puts the lives of workers at risk but can also cause damage to the site and the surrounding area as well as being financially devastating for businesses.

Fire prevention on the site

- Plan chosen areas for waste with fire and emergency procedures in place to curb and deal with a fire should it break out.
- Clear away rubbish and waste frequently to the chosen areas. Don’t let waste materials build up around the site.
- Never try to dispose of rubbish by burning it. Site ‘bonfires’ are prohibited and can get out of control easily.
- Electrical systems, comprising short-term supplies, must only be installed by a skilled electrician and must be frequently maintained.
- Site compounds are susceptible to fire because of: temporary heaters, smoking, intermittent occupation, clothes drying, waste packaging, old newspapers etc.
- Short-term heaters must be appropriately installed in a safe position and have guards fixed. Heaters should not be left on unoccupied.
- High-intensity lights should not be hidden or placed near flammable material. They must be firmly fixed to stop them from falling over. Treat them as though they are heaters.
- Do not smoke in areas of high fire risk or chosen ‘no smoking’ areas. Dispose of matches and cigarette butts cautiously.
- Control all hot works by a permit to work system to make certain that risks are effectively controlled.
- Before beginning hot works make sure the nearby region is free of flammable material. Non-removable items must be covered with heat proof blankets. Don’t underrate how far radiant heat and sparks can travel.
- Stop hot work at least 1 hour before the end of the shift, with fire checks at 30-minute interludes and up to and as well as 1 hour after the conclusion of the work.

Fire safety legislation

- The Regulatory Reform (Fire Safety) Order 2005
- The Dangerous Substances and Explosive Atmospheres Regulations 2002 (DSEAR)
- The Construction (Design and Management) Regulations 2007 (CDM)

Fire risk assessment

- Most construction site fires have simple causes and can be dealt with by simple precautions. The legislation requires that whoever is in control of the construction work must have carried out a risk assessment and be able to demonstrate.

Emergency plans

- Every construction site, no matter how small or low risk, should have an emergency plan. In finished buildings, there will always be alternative escape routes. However, when the building is under construction this may not be the case and a fire on a construction site can trap people. The purpose of an emergency plan is to make sure everyone on the site can reach safety in the event of a fire.

Fire warning systems

- A fire warning system will alert people to a fire on the site, allowing them to escape safely and quickly. On a small low-risk site shouting, 'fire' may be enough to raise the alarm. On a larger or high-risk site, it may be appropriate to have a manual bell or battery-operated site alarm with a distinctive sound that can be heard above the noise of the site. The fire alarms should be tested at least once a week.

Firefighting equipment

- Carrying out a risk assessment on the site will identify the hazards and the type of equipment required. On a small or low-risk site a single fire extinguisher may be sufficient. On a large or high-risk site, it may be necessary to install a fixed system such as fire sprinklers.

7.0ELECTRICAL SAFETY

- Every construction site is covered with electrical hazards, regardless of whether you are tearing down a structure or building something from the ground up. In order to keep your workers and workplace safe, you must follow safety precautions across the site.
- Here safety tips that you must follow in the construction site.

1. **Personal Protection:** Personal protection should come first as compared to any other piece of safety equipment as it directly protects you against electrical mishaps. The amount of personal protection required is based on your potential exposure to electricity. Use electrical gloves and footwear while handling electrical materials as they provide basic safety. Take extra precautions like using a face shield, fire-resistant helmet and protective eyewear and earmuffs while working with wiring or if you are in close contact with electrical equipment.

2. **Testing equipment:** Never handle any electrical wiring or equipment if you don't know how to operate it. The electrical power testing equipment provides the necessary protection from unwanted and potential deadly shocks. Ensure that the worksite is stocked with voltage detectors, clamp meters and receptacle testers.

3. **Cord protectors:** One good electric safety practice includes use of safe extension cords and outlet strips. As an extra measure, use cable covers and cord protectors. Use floor cable protectors for safety and ensure that they are highly visible to prevent tripping on the worksite.

4. **Voltage regulators and circuit breakers:** They are critical pieces of safety equipment that curb the problem before it gets worse. Always use a surge protector to shut off the worksite's power supply during an emergency. A voltage regulator helps in preventing equipment damage over time or damage during a surge of electricity.

5. **Precautions:** Some electrical hazards will occur and they would be out of your control. However, you can control some and reduce the risk of electrocution by being cautious at the worksite. Some precautions include knowing where the electrical wiring will be an issue on a construction site and label it for safety measures and using ground fault circuit interrupters for all receptacle outlets to prevent electrical shock.

6. **Equipment uses:** Using an electrical equipment at the workplace can end up becoming a very natural and comfortable thing for the workers. This may lead to improper use of tools or be practicing unknown hazards without realizing. Training the staff properly will help them identify the unknown improper shortcuts and thus reduce the risk of equipment-related electrocution. Apart from that, ensure that the co-workers know the proper way to use every tool, especially in direct electrical work.

7. **Identifying problems:** The dangers presented by the construction sites must never be overlooked. Encourage your workers to practice identifying any kind of abnormality or any kind of electrical hazard, such as identifying a distinct burning smell. Make a safety checklist and incorporate it into your daily routine. Create an environment where the workers feel comfortable to alert a supervisor in case there is any problem.

8. **Risk assessments:**Carry out an exhaustive and comprehensive risk assessment before any kind of work starts on the construction site. This helps in identifying the potential electrical hazards and ensuring that suitable control measures are in place to prevent them from causing harm to workers. It is important to familiarize yourself with the results of the risk assessment to understand which hazards you need to look out for.

8.0 ENVIRONMENTAL PROTECTION

- The general public has become increasingly more aware of environmental concerns in all aspects of life as public policy reflects. The US government continues to regulate environmental concerns in every

industry, including construction. It's more vital than ever to keep your construction projects as environmentally friendly as possible.

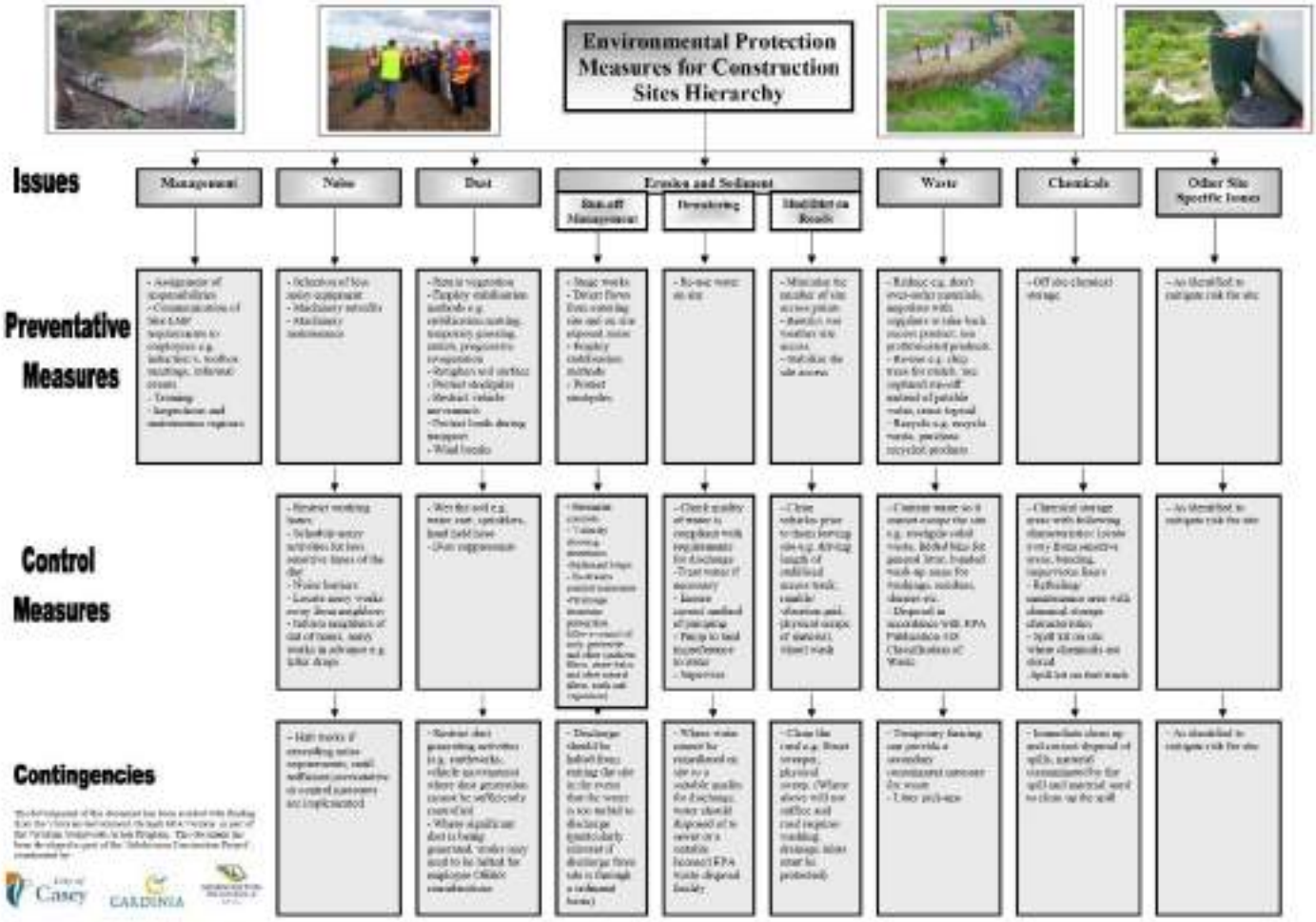
How to Protect the Environment During Construction

- Environmentally friendly business practices are a hot topic and the strong focus of businesses in nearly every industry, including construction. The great news is that often these solutions are not only better for the environment, but they're also better for your bottom line.

1. **Minimize Waste:**Construction produces a large amount of waste materials, period. There's no way around it, but you can and should look for ways to minimize the waste you're producing. Increasing the efficiency of your operations, optimizing the use of supplies and materials, and choosing products and methods that reduce waste are all great ways to reduce the production of waste materials for all your projects. Every little bit really does add up.
2. **Industrial Recycling:**Explore recycling initiatives specifically aimed at the construction industry like the EPA's Industrial Recycling Program. This program focuses on recycling construction and demolition debris in other construction applications on site.
3. **Efficient Energy Use:**Use tools, products, and materials that promote efficient energy use. Look for ways to improve the energy efficiency of your operations, materials used, and final products. Use the Energy Star Program as a guide.
4. **Choose Green Solutions:**Look for products and materials specifically designed to be more environmentally friendly. Consider products that reduce the environmental impact of specific parts of your operations such as using an inflatable bladder dam for all your dewatering applications.
5. **Protection of Ecological Resources:**It's important to protect the water, plant life, and animal species in the area of your project. Not only will the general public take note, but the government has regulations in place to protect the biodiversity of local ecologies. Your end goal is to complete your project with the highest quality, most efficient timeline, and the least environmental impact.

Protect the Environment AND Your Bottom Line

- There is an abundance of products and services in the market today that will increase your bottom line while making your projects more environmentally friendly. Explore solutions that optimize your project efficiency while minimizing your environmental impact. Use this guide on how to protect the environment during construction to get started.
- Hydrological Solutions is an industry leader in innovative dewatering solutions that improve your project efficiencies while reducing environmental impact.



9.0 CONCEPT OF GREEN BUILDING

- Green building is a whole-systems approach for designing and constructing buildings that conserve energy, water, and material resources and are more healthy, safe, and comfortable. Many thinks of solar panels when they think of "green" building.

- The reality is that environmentally sustainable building goes far beyond energy consumption. Building materials and use of landfills during construction can have detrimental effects on volunteers, home owners and the environment.

- Green building offers a response to the realization that the way we have been building everything from houses to skyscrapers is not sustainable. Many health problems today stem from, or are aggravated by poor indoor air quality and exposure to toxic substances contained in commonly used building products. Green building practices can eliminate these health damaging conditions.

Benefits

- Energy efficiency is one of the primary advantages of green building. Energy consumption can be dramatically slashed. Below are a few of the strategies that go into making a house exceptionally energy efficient.
- Orient the house to reduce solar gain in summer and capture the sun's light and warmth in winter.
- Carefully sized overhangs or awnings will protect windows from the summer sun while admitting the sun's warming rays in winter when it is at a lower angle known as a ground-source heat pump system, consumes no fossil fuels at all, and provides outstanding performance year-round with an extraordinarily low operating cost.
- Maximize natural light to reduce the need for electrical usage during the day
- Compact fluorescent lights (CFL's) are big energy savers. Incandescent bulbs are highly inefficient, converting just 10% of the energy they use into light — the other 90% produces only heat. GELs are up to six times more efficient and last up to ten times longer. Choose CFL's with warm color temperatures (around 2, 7000 to 3,000° Kelvin) which are indistinguishable from incandescent lights.

- Cut energy consumption further with clean, renewable energy from photovoltaic panels. During periods when the panels produce more power than the house is using, the electric meter will actually run backwards. In some locales, wind generated electricity is also an option
- All newly built homes to produce more energy than they consumed by 2020. Renovate all existing buildings to save energy. Ban incandescent light bulbs by 2010. Reduce greenhouse-gas emissions by 20% by 2020.
- Increase renewable energy from 9% to 20-25% of total energy consumptions by 2020.
- Bring transport emissions back to 1990 levels. Reduce vehicle speed limits by 10 kilometers per hour. Taxes and incentives to favour clean cars. Shift half of haulage by road to rail and water within 15 years. Develop rail and public transport.
- Reduce air pollutants quantitatively.
- Create a national network of green corridors and nature reserves.
- Increase organic farming from 2% to 6% of total acreage production by 2010 and to 20% by 2020.
- Ecological groups to be stakeholders, like trade unions, in government negotiations.
- Create a body to review planting of genetically modified crops on a case- by-case basis.

Design Considerations

- **Design an energy-efficient building:**Use high levels of insulation, high- performance windows, and tight construction. In southern climates, choose glazing's with low solar heat gain.
- **Design buildings to use renewable energy:**Passive solar heating, day lighting, and natural cooling can be incorporated cost-effectively into most buildings. Also consider solar water heating and photovoltaic-or design buildings for future solar installations.
- **Optimize material use:**Minimize waste by designing for standard ceiling heights and building dimensions. Avoid waste from structural over-design (use optimum-value engineering/advanced framing). Simplify building geometry. Design water-efficient, low-maintenance landscaping: Conventional lawns have a high impact because of water use, pesticide use, and pollution generated from mowing. Landscape with drought-resistant native plants and perennial groundcovers.
- **Mote it easy for occupants to recycle waste:**Make provisions for storage and processing of recyclables—recycling bins near the kitchen, under sink compost receptacles, and the like. Look into the feasibility of gray water: Water from sinks, showers, or clothes washers (gray water) can be recycled for irrigation in some areas. If current codes prevent gray-water recycling, consider designing the plumbing for easy future adaptation.
- **Design for durability:**To spread the environmental impacts of building over as long a period as possible, the structure must be durable. A building with a durable style ("timeless architecture") will be more likely to realize a long life.
- **Design for future reuse and adaptability:**Make the structure datable to other uses, and choose materials and components that can be reused or recycled.
- **Avoid potential health hazards—radon, mold, pesticides:** Follow recommended practices to minimize radon entry into the building and provide for future mitigation if necessary. Provide detailing to avoid moisture problems, which could cause mold and mild growth.
- **Renovate older buildings:** Conscientiously renovating existing buildings is the most sustainable construction.
- **Create community:**Development patterns can either inhibit or contribute to the establishment of strong communities and neighborhoods. Creation of cohesive communities should be a high priority.

UNIT-IV
CONTRACT MANAGEMENT

1.0 Contract Management

- Contract Management at its best is about managing risk, and managing relationships. In a simple form, a contract is a document describing a relationship between two parties, what each of them agrees to do, and who carries the risk if things don't turn out as planned.

Essential Elements of Successful Contract Management

- It isn't enough that an organization has professionals in place to handle construction contract management.
- Employees must be augmented with the presence of processes and software companions to satisfy increasing compliance and analytical needs.
- When a contract management strategy is successfully implemented, organizations can expect to see:
  - The expected business benefits and financial returns are being realized.
  - The supplier is cooperative and responsive to the organization's needs.
  - The organization encounters no contract disputes or surprises.
  - The delivery of services is satisfactory to both parties.

Stages of Contract Management

Contracts play a significant role in the end-of-quarter crunch and are broken up into stages to organize efforts and structure the typical contract process. When done manually, creating a contract can prove quite time-consuming. The process in the stages of contract management includes several of the following steps:

- **Initial requests:** The contract management process begins by identifying contracts and pertinent documents to support the contract's purpose.
- **Authoring contracts:** Writing a contract by hand is a time-consuming activity, but through the use of automated contract management systems, the process can become quite streamlined.
- **Negotiating the contract:** Upon completion of drafting the contract, employees should be able to compare versions of the contract and note any discrepancies to reduce negotiation time.
- **Approving the contract:** The instance in which most bottlenecks occur is getting management approval. Users can pre-emotively combat this by creating tailored approval workflows, including parallel and serial approvals to keep decisions moving at a rapid pace.
- **Execution of the contract:** Executing the contract allows users to control and shorten the signature process through the use of electronic signature and fax support.
- **Obligation management:** This requires a great deal of project management to ensure deliverables are being met by key stakeholders and the value of the contract isn't deteriorating throughout its early phases of growth.
- **Revisions and amendments:** Gathering all documents pertinent to the contract's initial drafting is a difficult task. When overlooked items are found, systems must be in place to amend the original contract.
- **Auditing and reporting:** Contract management does not simply entail drafting a contract and then pushing it into the filing cabinet without another thought. Contract audits are important in determining both organizations' compliance with the terms of the agreement and any possible problems that might arise.
- **Renewal:** Using manual contract management methods can often result in missed renewal opportunities and business revenue loss. Automating the process allows an organization to identify renewal opportunities and create new contracts.

2.0 PROJECT ESTIMATION

- An estimate for any construction work may be defined as the process of calculating the quantities and costs of the various items required in connection with the work.
- Before the start of any work for its execution, the owner of the builder should have a thorough knowledge of the volume of work. The minute's details can help him understand if the work can be completed within the stipulated time frame and budget.
- It also enables him to understand the probable cost that may be incurred to complete the proposed work. Therefore, it is necessary to list the probable costs or develop an estimate for the proposed work from its plans and specifications.
- An estimate is prepared by calculating the quantities from the drawings for various items and multiplying them with the unit cost of the item concerned. To prepare an estimate one requires -
- **Drawing:** The drawing is the basis from which quantities of various items for a work are calculated. The drawings consist of the plan, the elevations, and the sections through important points.
- **Specifications:**
    - **General Specification:** The general specification forms the general idea for the project. In this, the nature and class of work and the names of materials that should be used are described.
    - **Detailed Specification:** Detailed specification describes every item of work in the estimate. This specification of work serves as a guide to execute the work to the owner's satisfaction.
- **Rates:** Rates for different items of works are vital factors to determine the estimated cost.
- Standing circulars for taxes and insurance etc. are required to fix up rates of those items which are not in the schedule of rates.

Purpose of Estimation

1. To ascertain the necessary amount of money required by the owner to complete the proposed project. For public construction works, estimates are required in order to obtain administrative approval, allotment of funds, and technical sanctions.
2. Ascertain quantities of materials required to program their timely procurement.
3. Calculate the number of workers that are to be employed to complete the work within the scheduled time of completion.
4. Assess the requirements of tools and equipment required to complete the work according to the program.
5. Fix up the completion period from the volume of works involved in the estimate.
6. Draw up a construction schedule and program.
7. Justify the investment from the benefit-cost ratio.
8. Invite tenders and prepare bills for payment.
9. Estimation for an existing property is required for valuation.

Types of Estimates

1. Detailed Estimate

- This includes the detailed particulars for the quantities, rates, and costs of all the items involved for the satisfactory completion of a project. This is the best and the most accurate estimate that can be prepared.
- A detailed estimate is accompanied by -Report, Specifications, Detailed drawings showing plans, Design data and calculations and, Basis of rates adopted in the estimate. Such a detailed estimate is prepared for technical sanction, administrative approval, and also for the execution of a contract with the contractor.

2. Preliminary or Approximate or Rough Estimate

- This is an approximate estimate to determine an approximate cost in a short time and thus enables the authority concerned to consider the financial aspect of the scheme, for according sanction to the same.

- Such an estimate is framed after knowing the rate of similar works and from practical knowledge in various ways for various types of works.

3. Quantity Estimate or Quantity Survey

- This is a complete estimate or list of quantities for all work items required to complete the concerned project. The quantity of each item of work is worked out from the respective dimensions on the drawing of the structure.
- The purpose of the Bill of quantities is to provide a complete list of quantities necessary for the completion of any engineering project, and when priced, it gives the estimated cost of the project.

4. Revised Estimate

- A revised estimate is a detailed estimate of the revised quantities and rates of items of works originally provided in the estimate without material deviations of a structural nature from the design originally approved for a project.
- It is accompanied by a comparative statement abstract form showing the probable variations for quantity, rate, and amount for each item of work of the project compared with the original estimate side-by-side stating the reasons for variations. For fresh technical sanction, a revised estimate is prepared and submitted.

5. Supplementary Estimate

- During the progress of the work, some modifications or additions due to material deviation of a structural nature from the design originally approved may be thought necessary for the development of a project.
- A supplementary estimate includes all such works. The method of preparation is the same as that of a detailed estimate, and it should be accompanied by a full report of the circumstances which render its necessity.

6. Complete Estimate

- The complete estimate is related to the work in addition to the main contractor to the 'detailed estimate.'

7. Annual Maintenance or Repair Estimate

- After completion of a work, it is necessary to keep the maintenance aspect in view for its proper functioning. An estimate is prepared for the items which require renewal, replacement, repairs, etc. for maintenance purpose.
- The total estimated cost of maintenance of a structure is generally kept within the prescribed limits on the percentage basis of the cost of construction of the structure and its importance. This cost can vary according to the age and importance of the structure.

3.0 THE CONSTRUCTION ESTIMATION PROCESS

- **Commissioning a Project:** Commissioning is essentially a verification process that ensures a builder designs, constructs, and delivers a project according to the owner's requirements. It begins early in the construction process and can last until up to a year of occupancy or use.
- **Determining Requirements**: The first real step in constructing a project is a pre-design phase or planning phase. The pre-design phase involves defining a project's requirements: what its function(s) will be, how much it should cost, where it will be located, and any legal requirements it must comply with.
- **Forming a Design Team:** The project owner contracts with an architect who will then select other specialized consultants to form a design team. Complex projects and projects which require meeting specific design requirements — such as acoustics or housing hazardous materials — will have more specialized consultants on board to ensure the design meets requirements.

- **Designing the Structure**: This step deals with the architect creating a series of designs. The architect works first with the owner to decide on the broad strokes of the design and then increasingly closely with the other members of the design team to flesh out the structure's design in accordance with requirements.
- **Bidding Based on the Scope of Work:** Once the construction documents are finalized, they are released to contractors who wish to bid on the project. Along with these bidding documents, they include instructions on how to submit bids, a sample of the contract agreement, and financial and technical requirements for contractors.
- **Signing the Contract:** Once the contractor has been selected, they execute a set of contract documents with the owner. The contract documents encompass the bidding documents, which now function as a legal contract between owner and contractor. Contracts can follow a number of models, depending on how complete the construction design is and how the owner and contractor bear risks.
- **Construction**: During the construction phase, the contractor oversees building in accordance with the construction documents. A general contractor will hire specialized subcontractors for different sets of construction tasks, such as plumbing or foundation work. Throughout the construction process, the contractor engages in careful cost control, comparing actual expenditure with forecasted expenditure at multiple points in the construction process.
- **Close-Out:** When the builder comes close to finishing a structure, the contractor requests the architect perform a substantial completion inspection in which the architect verifies the near-complete status of the project. At this stage, the contractor provides the architect with a document called the punch list, which lists any incomplete work or needed corrections.
- **Completion:** After the contractor completes all the incomplete work detailed on the punch list, the architect performs a final inspection. If the contractor has completed the structure according to construction drawings and specifications, the architect will issue a certificate of final completion, and the contractor is entitled to receive the full payment.

4.0 CONTRACT DOCUMENTS

- On a construction project, contract documents are the group of documents that define the price, conditions, clauses, schedule and scope of the executed work, along with any other job-specific details. They can be both written and graphic, and act as a legal definition of the contract.
- A construction contract is a legal agreement between contractors and clients that presents, in detail, the specifications and terms of a project. Unlike other industries, a construction contract isn't one single document. Instead, it's a collection of documents prepared by a number of different parties that present the specifications and terms of a project.
- Managing all of these different contract documents — and different versions of each one — can be difficult. It's important for contractors to establish a document management strategy to ensure that change orders and evolving specifications don't fall through the cracks.

1. The Construction Agreement

- The agreement is the most fundamental document in a construction contract bundle. This is basically "the contract," a foundation that the rest of the project details are built upon. This document will set out the general purpose of the contract and the contract price.
- The agreement itself is just the beginning. Construction contracts need as much detail as possible to avoid mistakes, conflicts and delays, saving everyone on the project time and money.

2. General Conditions

- General conditions are essentially the framework of the construction contract documents. They provide the "hows" of the project.
- Most importantly, general conditions establish all the rights and obligations of the contracting parties. Additionally, it will lay out the roles of every party and the responsibilities of each.
- The general conditions provide the game plan to proceed in the event of any issues on the project, often within a group of detailed clauses. This includes the process for submitting change orders, approval of payment applications, and any notice requirements.
- The general conditions will also include all the suspension, termination and alternative dispute resolution procedures.

3. Special Conditions

- Special conditions are typically an addition or amendment to the general conditions section. This document will detail the specific clauses and conditions for each task or project. For example, special conditions will include specific instructions that only apply to one job or portion of the build.

4. Scope of Work

- A clearly defined scope of work**,** also known as a statement of work, is a crucial element of a construction contract. This document will describe, in detail, the precise tasks and objectives of each contractor.
- The scope of work determines the amount of work the contractor needs to complete to fulfill their contractual obligations. The scope is a critical reference point when preparing change orders and punch lists.
- Contractors and subs need to know what type of work falls outside their scope of work to avoid performing additional work without additional compensation.

5. Drawings

- Every construction project should include a set of drawings or blueprints. Drawings provide a simple overview of the project as a whole. The architect or construction manager should present these to contractors before any construction activities begin.
- This document informs the contractors what and how to build the structure. Construction drawings are a collaborative effort between the architect, the clients, and the contractor. Ideally, these are the most up-to-date versions of the drawings.

6. Specifications

- The section for construction specifications contains all the technical data and performance requirements. The specs should detail the materials and techniques the contractors must use on any given task. It will outline all the quality standards, acceptable materials, and any quality testing necessary to ensure compliance.
- The architect or the engineer will prepare these, and the client will verify them. In turn, the client provides the specs to contractors who need to perform according to those details. However, any defective specifications might result in the client being liable to the contractor for increased costs they may have incurred due to the specs.
- In some cases, the contractor may want to substitute one material for another for a variety of reasons. Contractors should always adhere closely to the specifications prepared by the architect or engineer.
- However, in the event that a change is necessary, it is important to follow the steps required to make a substitution request.

7. Bill of Quantities

- A bill of quantities isn't optional on some contracts, but it can be helpful. A bill of quantities is an itemized list of the various materials, parts, and labor required. This list is typically provided during the bidding process.

- The purpose of this is to allow prospective bidders to be able to estimate their costs more accurately and simplify the evaluation process. Typically, a quantity surveyor or building estimator prepares the bill of quantities.
- A bill of quantities will often look similar to a schedule of values, to the point where some people use the terms interchangeably.

8. Construction Schedule

- A well-formulated construction schedule requires close attention to detail. Any updates should be readily accessible to everyone on the project.
- Construction managers develop schedules in a number of different ways, such as Critical Path Method, Gantt charts, a line of balance or any other schedule that meets the project's needs. Schedules can be relatively simple outlines of the project.
- However, the larger and more complex the project is, the greater the need for more formal, detailed approaches. Detailed construction schedules keep everyone aware and informed about the project status, which can reduce both conflicts and delays.

9. Schedule of Values

- A schedule of values is provided by a contractor and lists all the work items from start to finish. It will allocate the entire contract sum among the various portions of the work. The schedule of values is also a useful management tool to form the basis for submitting and reviewing progress payments. This document can help keep the cash flowing and bills paid on time.

5.0 CLASSIFICATION OF CONSTRUCTION CONTRACTS

- Based on the various parameters following are the construction contracts followed in the construction industry for proper implementation of construction contract management.

1. Unit Rate/ Unit Price Contract

- Also called a Unit cost contract/item rate contract/ value contract /measurement contract or schedule rate contract. In this type of construction contract management, the contractors are required to quote rates for individual items of work based on a schedule of quantities furnished by the owner.
- This schedule indicates a full description of the item, estimate quantities, and their units. The contractors are required to express rates and work out the cost against each item and thereby draw up the total amount tendered for the work.
- This type of contract is normally utilized where the quantity of work cannot be established such as civil engineering construction projects where excavation of soil and rock are involved. The contractor is paid based on the units that have been put in place and verified by the owner

2. Percentage Rate Contract

- In this type of contract, the owner prepares a schedule of items with quantities rate units and the amount shown therein. The contractors are required to offer percentages above, below, or at par with the rates given in the schedule. The percentage quoted by the contractor is applicable to the overall schedule.
- Simply put, when the lowest rate and comparative position among the contractors are already specified prior to the opening of the tender, then the percentage rate contract is used. A percentage contract is a type of contract where there is no possibility of an unbalanced tender.

3. Cost plus Percentage Contract

- This type of contract generally adopted when conditions are such that the rates of labor, material, etc. are liable to fluctuate and there is an element of uncertainty in the scope of the work.
- In this type of contract, there is an arrangement between the owner and the contractor by which the parties agree that the work ordered would be completed and paid for on the basis of actual cost incurred plus a fixed percentage as overhead and profit.

4. Time and materials Contracts.

- A time and materials contract means the buyer pays for the time spent by the builder and his subcontractors and must pay for the actual costs of construction materials.
- There is uncertainty involved for the buyer here as well since the buyer has to pay for extra costs or time overruns. Many times, and materials contracts will contain maximum price clauses as well.

5. Lump-Sum Contract

- Lump-sum or fixed-price contracts. Lump-sum contracts involve the buyer agreeing to pay a set price and the contractor or builder agreeing to complete the project for that set price. With this type of contract, the buyer has certainty because he knows what his final costs will be unless changes are made.
- The builder or developer takes on the risk because if prices go up or problems arise, the buyer will not have to pay any more money. Some lump-sum contracts include allowances, which can mitigate risk to builders because if the buyer goes over the allowance, the cost is borne by the buyer.
- Lump-sum contracts can sometimes include benefits or incentives for completing projects under budget or in a shorter period of time, and can sometimes include liquidated damage clauses so the builder will have to compensate the buyer for being late to finish.

6. BOT (Build, Operate, and Transfer) Contract

- A type of contract between a private company and a government body, in which the private company finances, design, construct, operate, and maintains an infrastructure project for a period of time and then transfers the ownership of the project to the government. During this period the private party is entitled to retain all revenues generated by the project and is the owner of the regarded facility.
- The basic difference from the other conventional projects/ contract;
  - The returns are spread over a longer period
  - Sound financial and engineering skills are warranted
  - No protection against any price's variation during the implementation period,
  - Cost and time overrun upsets the returns.
  - Extension of time granted by authority does not provide much remedy.

7. Target Price Contract

- In this contract type, the actual cost of completing the project is compared with a target cost previously agreed. If the actual cost exceeds the target cost, some of the cost overrun will be borne by the contractor (pain share) and the remainder by the owner in accordance with the agreed formula.
- Such an approach helps t align the interest of the parties since both will have an interest in working together in order to reduce the costs of the projects.

6.0 BIDDING

- Construction bidding is the process of submitting a tender by the contractor to the client as a proposal to conduct or manage a particular construction project. The bidding process is an incredibly important part of a construction project. This enables firms and companies to hire contractors.

Construction Bidding Process

1. The client or general contractors send bid invitations to the contractors or the subcontractors.
2. The contractors or the subcontractors receive the invitation that includes:
   Scope of Work
   Time of Completion
   Penalty
   Pre-Qualification Details
3. Contractors or Sub-Contractors download the tender document and review the project based on their respective cost codes.
4. Contractors or Sub-Contractors submit their bid to the client or general contractor.

5. The general contractor or client awards the bid to the subcontractors with a most competitive bid and it is converted into a commitment.

Decisions in Construction Bidding Process

1. The Project Delivery Method

There are four traditional project delivery methods. They are:

A. Design-Bid-Build or Design Tender
B. Construction Management at Risk
C. Design-Build D-B
D. Integrated Project Delivery (IPD)

- The four major project delivery systems mentioned above share the common goal of helping the owners built new structures on time and on budget. These methods also ensure quality and performance requirements.

A. Design-Bid-Build or Design Tender

- This is the traditional method and is commonly employed for the construction of non-residential buildings, mainly under government projects. In a DBB method, the owner hires a designer or an architect independently.
- This is performed by the contractor who is managing the construction. Once the design is completed by the architect, bids are solicited from the contractor by the owner so that the designs can be executed.

B. Construction Management at Risk (CMAR Method)

- The CMAR method is an alternative to the DBB method that helps in reducing the costs. In this method, design and construction are handled by different firms. Here the construction manager is involved in the project from the start of project, even before the design of the project.
- The CM can even help in choosing the architect for the project. Once this step is done, the project is moved forward by the CM and the architect. They work together during the design phase.
- This method is mainly employed for complex projects. The CM is chosen by the owner on the basis of his or her experience and qualifications and not on the basis of the lowest price criterion. The bid of CM to the owner is a guaranteed maximum price (GMP). This cost represents the:

  Pre-construction service
  Actual construction
  The Fee of Construction manager
  Possible Contingencies

C. Design-Build (D-B)

- In DB Method, the owner provides the contract to a single entity that can handle both the design and construction. Here, one price covers both the phases of construction.
- This entity is called a design-builder or design-build contractor. In DB, the design-builders are accountable to the owner for all aspects of the project.

D. Integrated Project Delivery (IPD)

- The IPD method is also called an integrated team method. This is one of the newly developed projects delivery methods. This method employs, owner, architect and contractor as a team, and the risk is shared equally.

2. Construction Procurement Methods

- After the selection of the project delivery method, the next step is to bother about the procurement method through which the construction services are obtained.
- Construction procurement is generally classified into:
- **Best Value Source Method (BVS):** In this method, the buyers and the contractors are awarded the contract based on price and performance. These records taken into consideration are past performance, robust management approach, qualifications of the staff and other specific factors.

- **Negotiated Tendering:** In this method, the contactors are selected without any form of advertising or competitive bidding. A potential builder is chosen and negotiated with reference to the price and the technical requirements. The contractor who makes a favorable proposal is taken into consideration by the government. This proposal is not opened publicly.
- **Sole Source or Direct select:** In this procurement method, a single source procurement method. This is a non-competitive method that only uses a single provider who can fulfill all the requirements of the project.
- **Low Bid or Lowest Bid:** Competitive bidding with the lowest bidder is the principle behind the low bid procurement method. This is one of the traditional procurement methods. Government and public construction entities are built as per this procurement method

3. Contract Model

The contract format that is presented in the construction bidding process must be carefully developed. The owner is supposed to suggest the type of contract he is willing to make. The type of contract developed determines how cost and the profit are covered. Top used contract types are:

Cost plus Fee Contract
GMP Contract
Time and Material Contract
Fixed Price Contract
Lease Leaseback

7.0 Procurement

- **Procurement** refers to techniques, structured methods, and means used to streamline an organization's procurement process and achieve desired results while saving cost, reducing time, and building win-win supplier relationships. Procurement can be direct, indirect, reactive, or proactive in nature.

What's the difference between indirect, direct, and services procurement

- Direct, indirect, and services procurement are subsidiaries of the overarching procurement process and differ in aspects like definition, assignments, and more. By taking a deeper look at the difference between these processes and understanding what they comprise, stakeholders will have an easier time taking appropriate measures to fulfill the need.

Direct Procurement	Indirect Procurement	Services Procurement
Acquisition of goods, materials, and/or services manufacturing purposes	Sourcing and purchasing materials, goods, or services for internal use	Procuring and managing contingent workforce and consulting services
Ex: Raw materials, machinery, and resale items	Ex: Utilities, facility management, and travel	Ex: Professional services, software subscriptions, etc.
Drives external profit and continuous growth in revenue	Takes care of day-to-day operations	Used to plug process and people gaps
Comprises of stock materials or parts for production	Used to buy consumables and perishables	Used to purchase external services and staff
Establish long-term, collaborative supplier relationships	Resort to short-term, transactional relationship with suppliers	Maintain one-off, contractual relationships with suppliers

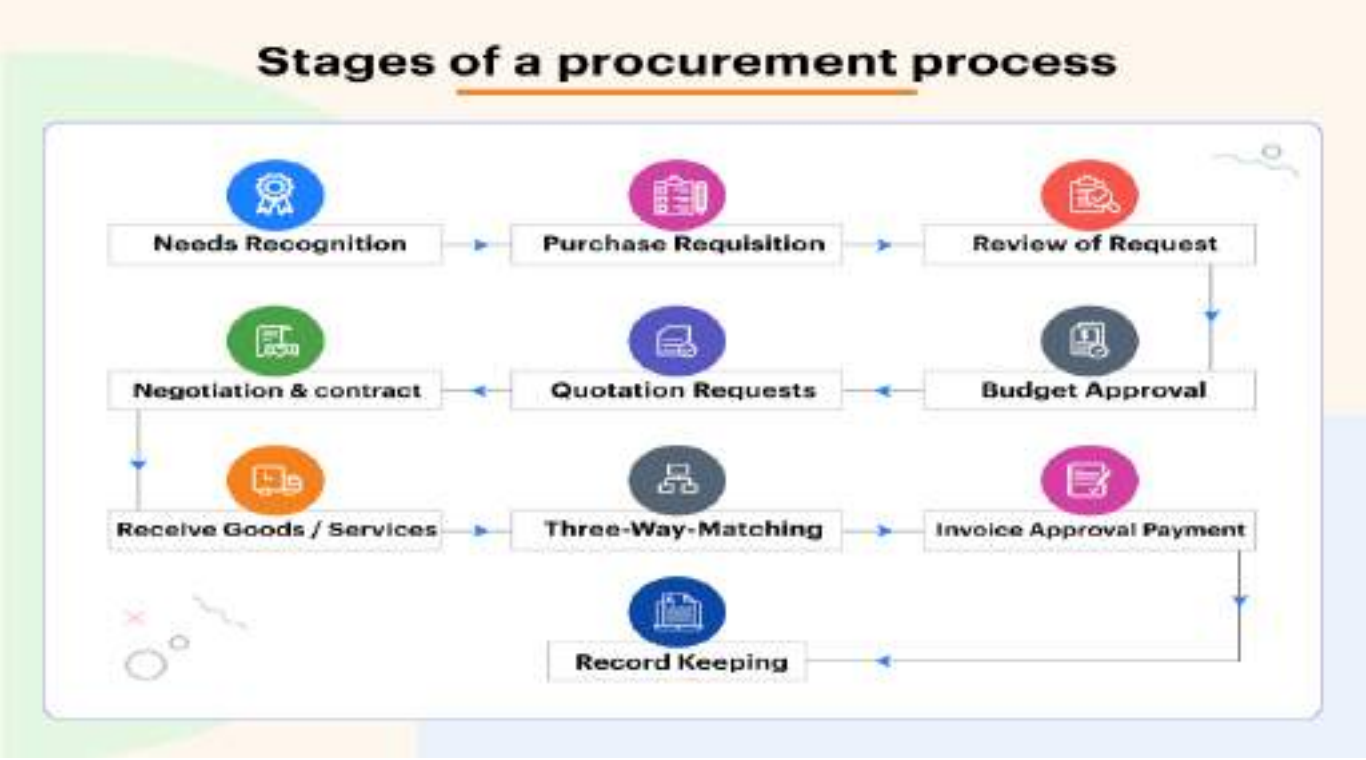
What is a Procurement Process

- It's the series of processes that are essential to get products or services from requisition to purchase order and invoice approval.
- The procurement process in an organization is unique to its context and operations. Regardless of the uniqueness, every procurement management process consists of 3 Ps', namely Process, People, and Paperwork.

- **Process:** The list of rules that need to be followed while reviewing, ordering, obtaining, and paying for goods/services. Checkpoints/steps increase with the complexity of the purchase.
- **People:** These are stakeholders and their specific responsibility in the procurement cycle. They take care of initiating or authorizing every stage of the process. The number of stakeholders involved is directly proportional to the risk and value of the purchase.
- **Paper:** This refers to the paperwork and documentation involved in every stage of the procurement process flow, all of which are collected and stored for reference and auditing reasons.

Steps involved in a Procurement Process

- Every **procurement process** involves several elements, including requirements determination, supplier research, value analysis, raising a purchase request, review phase, conversion to purchase order, contract administration, monitoring/evaluation of received order, three-way matching, payment fulfillment, and record keeping.
- Here are the 7 steps involved in procurement process:
    - Step 0: Needs Recognition
    - Step 1: Purchase Requisition
    - Step 2: Requisition review
    - Step 3: Solicitation process
    - Step 4: Evaluation and contract
    - Step 5: Order management
    - Step 6: Invoice approvals and disputes
    - Step 7: Record Keeping



Step 0: Needs Recognition

- The needs recognition stage of a procurement process enables businesses to sketch out an accurate plan for procuring goods and services in a timely manner and at a reasonable cost.

Step 1: Purchase Requisition

- Purchase requisition are written or electronic documents raised by internal users/customers seeking the procurement team's help to fulfill an existing need. It comprises key information that is required to procure the right goods, services, or works.

Step 2: Requisition review

- The procurement process will officially commence only after the purchase requisition is approved and cross-check for budget availability. In the review stage, functional managers or department heads review the requisition package and double-check if there is a genuine need for the requested goods or service and also verify whether necessary funding is available.
- Approved purchase requests become POs, while rejected requests are sent back to the requisitioner with the reason for rejection. All these can be handled with a simple purchase order software

Step 3: Solicitation process

- Once a requisition is approved and PO is generated, the procurement team will develop an individual procurement plan and sketch out a corresponding solicitation process. The scope of this individual solicitation plan depends ultimately on the complexity of the requirement.
- Once the budget is approved, the procurement team forwards several requests for quotation (RFQ) to vendors with the intention to receive and compare bids to shortlist the perfect vendor.

Step 4: Evaluation and contract

- Once the solicitation process is officially closed, the procurement team in conjunction with the evaluation committee will review and evaluate supplier quotations to determine which supplier will be the best fit to fulfill the existing need.
- Once a vendor is selected, the contract negotiation and signing are completed, and the purchase order is then forwarded to the vendor. A legally binding contract activates right after a vendor accepts a PO and acknowledges it.

Step 5: Order management

- The vendor delivers the promised goods/services within the stipulated timeline. After receiving them, the purchaser examines the order and notifies the vendor of any issues with the received items.

Step 6: Invoice approvals and disputes

- This is a crucial step in the procurement process and having procurement software like KissflowProcurementCloud gives you a competitive edge over others. With Kiss flow, you can perform three-way matching between GRN, Supplier Invoice and PO to check if you have received the order correctly and there aren't any discrepancies. Once three-way matching is complete, the invoice is approved and forwarded to payment processing.

Step 7: Record Keeping

- After the payment process, buyers make a record of it for bookkeeping and auditing. All appropriate documents right from purchase requests to approved invoices are stored in a centralized location.

8.0 CONSTRUCTION PLAANING

- Planning is the first step of construction project management philosophy of planning, organizing and controlling the execution of the projects.
- Construction project planning and project scheduling is two separate and distinct function of the project management.

Definition of Construction Planning

- Planning is a bridge between the experiences of the past projects and the proposed actions that produces favourable results in the future.
- It can also be said that it is a precaution by which we can reduce undesirable effects or unexpected happenings and thereby eliminating confusion, waste, and loss of efficiency.
- Planning involves prior determination, specification of factors, forces, effects and relationships necessary to reach the desired goals.

Planning Philosophy

- Planning should be done logically, thoroughly and honestly to have a chance to succeed. The difference between previous projects and current projects shall be known to make any exceptional features in the basic planning logic.
- These differences can be unusual client requirement, out of the way location, potential external or internal delaying factors etc. These potential problems shall have to be tackled in order to reduce their negative effect preparing master plan of the project and later scheduling of the project. Provide each aspect of the plan an individual scrutiny with input from past experiences and from experts.

Types of Construction Project Planning

There are several types of project planning. The three major types of construction project planning are:

- **Strategic planning:** this involves the high-level selection of the project objectives
- **Operational planning:** this involves the detailed planning required to meet the strategic objectives
- **Scheduling:** this puts the detailed operational plan on a time scale set by the strategic objectives.

Strategic planning

- This is done by the owner's corporate planners. In this they decide what project to build and what the completion date has to be to meet the owner's project goals. The construction teams formulate the master construction execution plan within the guidelines set in the strategic and contracting plans.

Operational Planning

Operational planning is done by construction teams. They ask certain questions before making operational plan for the project. They are:

- Will the operational plan meet the strategic planning target date?
- Are sufficient construction resources and services available within the company to meet the project objectives?
- What is the impact of the new project on the existing work load?
- Where will we get the resources to handle any overload?
- What company policies may prevent the plan from meeting the target date?
- Is usually long delivery equipment or materials involved?
- Are the project concepts and design firmly established and ready to start the construction?
- Is the original contracting plan still valid?
- Will it be more economical to use a fast-track scheduling approach?

What is Construction Master Plan?

- A construction master plan addresses how will the project be planned, organized, and major work activities be controlled to meet the goals of finishing the work on time, within budget and as specified.
- Contracting plan is the major consideration in formulating the master construction plan, which answers a lot of questions. Questions related to government and social restraint, resources for construction, owner's policies or legal requirements, contractual requirement affecting master plan are not answered by contracting plan. Answers to these questions must be found during the development of the project execution plan. Project execution plan shall be reviewed and evaluation shall be done as the work progresses. Minor variations are common but major changes shall be considered with extreme caution. The construction project master plan shall be completed and approved and after that time plan (scheduling), budget plan, resource plan shall be carried out.

9.0 PROJECT PLANNING TECHNIQUES

- **Critical Path method:** was developed "in the late 1950s", and since then, it is used widely for scheduling projects, especially in construction, aerospace and defense, software development, IT, etc; In this method, activities are connected by using dependencies in a network diagram and forming paths, making forward and backward calculations (Kathy). In other words, this method tells the earliest starts (ES), earliest finishes (EF), latest starts (LS), and latest finishes (LF) of each activity in the

project. I believe this method is much more efficient than other methods for scheduling because this method gives information about the duration, earliest start, and the deadline, in which each activity should be completed.

- **Gantt chart:** It is one of the easiest methods of the project schedule to prepare. Its activities are represented as bars and the length of each bar represents the activity duration. The beginning and the end of the bar show the start and end date of each activity. Depending on the project execution plan and resource availability, these bars may be sequential or run in parallel (Kathy).
- **Program Evaluation and Review Techniques (Pert):** was developed by the "US Navy in the Program Evaluation and Review Techniques (Pert): was developed by the "US Navy in the late 1950' s for Ballistic Missile Program" in order to find a simple system to organize complex objectives and thousands of contractors (Kathy). In this method, the longest path can be identified by making forward and backward calculations.
- **Work Breakdown Structure:** is an outline of the construction project with different levels ofdetail. This method categorizes all the tasks of work project into subsections in a hierarchical structure, and it shows their relationship with each other. This method also serves as a framework for tracking cost, work performance, and progress
- **Activity on Node diagram:** is another method used to create project networks. Nowadays, this method is used mostly; In this method, each task will be presented in different shapes of boxes, in which they are joined together by an arrow (Gray, 166). And, the arrows represent the relation between the activities and the order of each of them.
- **Resource Allocation Chart:** used in projects where there is a competition between activitiesfor project resources. Resources could be considered as materials, specific labor types, transportation resources, and so on (Kathy). This method shows the starting, ending, and duration of each activity in a table.
- **Line of balance chart (Linear Scheduling Method):** is another method for project scheduling. This method is mostly used for several repetitive tasks of a project. When a project involves 3-5 tasks for a long-distance area, such as constructing roads, drilling, digging wells and etc, then this method is the best option. For instance, figure 11 below shows a schedule, using a linear scheduling method for a project with five repetitive activities, such as site clearing, drainage, sub grade, base course, and paving for 50 stations. So each activity is done for a long-distance area and requires a long period of time to be completed.
- **S-curve (cumulative progress chart):** is a graphical representation of project progression inpercentage versus time. Same as the Gantt chart method, this method presents both the planned and actual scheduling of the project. The purpose is to see the difference and progress of the work and improve future scheduling. Similar to the time-scaled arrow diagram, this method only shows the duration, starting, and finishing date of each activity without deciding on the earliest and latest start with the earliest and latest finish. It is also called cumulative progress chart.

10.0 PLANNING OF MANPOWER, MATERIAL, FINANCE, AND MACHINERY

For any given work, the resources required are manpower, materials, money and machinery.

Planning of Manpower

- Manpower requirements of the project in a tabular form for various stages. The labour schedule serves the following purposes during the construction stage.

TYPE OF WORKER	WEEK-1	WEEK-2	WEEK-3	WEEK-4	WEEK-5
Foreman	1	1	1	1	1
Carpenters	-	-	-	1	1
Welders	-	-	3	2	1
Mixer Operator	-	-	1	-	1
Masons	1	1	2	2	1
Bar benders	-	2	1	-	-
Labourers	3	3	10	6	3

Planning of Material

- Disruption of work due to shortage of materials can be avoided by using a material schedule or planning.
- The material panning may be prepared either month-wise or week-wise depending on the extent of the project and storage space.

S.NO	TYPE OF MATERIAL	QUANTITY	WEEK-1	WEEK-2	WEEK-3	WEEK-4	WEEK-5
1	Cement bags	No.	110	110	115	120	130
2	Bricks	No.	4500	4000	5500	3300	2600
3	Sand	Cum (cubic meter)	0	20	35	25	15
4	Aggregate	Cum (cubic meter)	20	35	30	25	30
5	Steel	Quintal	-	2	10	2	-

Planning of Finance

- Planning of finance essentials both for the pre-tender and construction stages.
- A finance schedule shows the amount of cash required at different stages of the Construction project/process.
- It enables long-term financial planning for the entire project to be carried out in an efficient manner.
- It also considers cash inflow from the running bills and indicates finances required for the successful completion of the project.

Planning of Equipment/machinery

- Machinery required to be deployed on the project. Delays in the work may occur due to non-availability or breakdown of equipment.

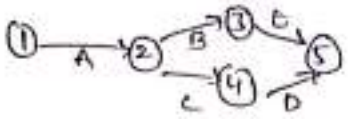
TYPE OFMACHINARY	WEEK-1	WEEK-2	WEEK-3	WEEK-4	WEEK-5
Concreter mixer	-	-	1	-	-
Vibrator	-	-	1	-	-
Welding set	-	-	1	1	1
Truck	-	-	1	1	1
Equipment for Erecting trusses (a framework)	-	-	-	1	-

UNIT- V

Project Scheduling

CPM – It is also called as critical path Analysis (CPA)

- It is an algorithm for scheduling a set of project activities.
- A critical path is determined by identifying the longest stretch of dependent activities and measuring the time required to complete them from start to finish.



- the CPM is a project modelling technique developed in the 1950 by Morgan R. Walker & James E Kelley.
- PERT which was developed by Booz Allen Hamilton & U.S. Navy
- CPA is commonly used with all-forms of projects, including construction, aerospace & defense, software development, engineering & plant maintenance.
- CPM was used the first time in 1966 for major skyscraper development of construction the former world trade center twin towers in Newyork city

→ CPM is a technique used for the planning & controlling the most logical & economic sequence of operations for completing a project

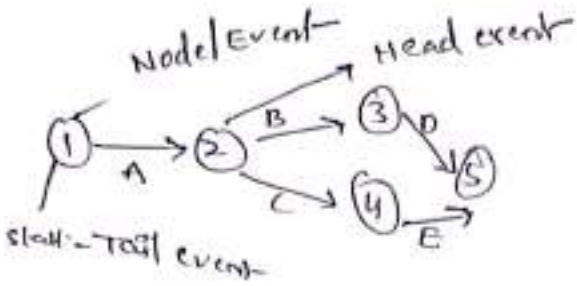
→ The project is analysed into different activities whose relationships are shown on the network diagram.

→ The network is then utilised for optimising the use of resources, progress and control.

→ Critical path can be identified by simply listing out all the possible paths from the start node of the project to the end node of the project and then selecting the path with the maximum sum of activity times on that path.

Guide lines for Network construction

1. The start event & ending event of an activity are called tail event & head event respectively
2. The network should have a unique starting node (Tail event)



3. The network should have a unique completing node (head event)
4. No activity should be represented by more than one arc in the network
5. No two activity should have the same starting node & the same ending node
6. Dummy activity is an imaginary activity indicating precedence relationship only, Duration of a dummy activity is zero

Two phases

1. Determines earliest start time (Es) of all the nodes this is called forward pass
2. Determines latest completing times (Lc) of various nodes this is called backward pass.

Determination of earliest start time

$$Es_j = \max_i [Es_i + D_{ij}]$$

i = starting activity
j - Ending activity

Determination of Latest completion time (LC_i)

$$LC_i = \min_j \left[LC_j - D_{ij} \right]$$

Conditions for critical path

$$ES_i = LC_i$$

$$ES_j = LC_j$$

$$ES_j - ES_i = LC_j - LC_i = D_{ij}$$

Total Floats

It is the amount of time that the completion time of an activity can be delayed without affecting the project completing time

$$TF_{ij} = LC_j - ES_j - D_{ij}$$

(OR)

$$TF = EST - LST$$

(or)

$$EFT - LFT$$

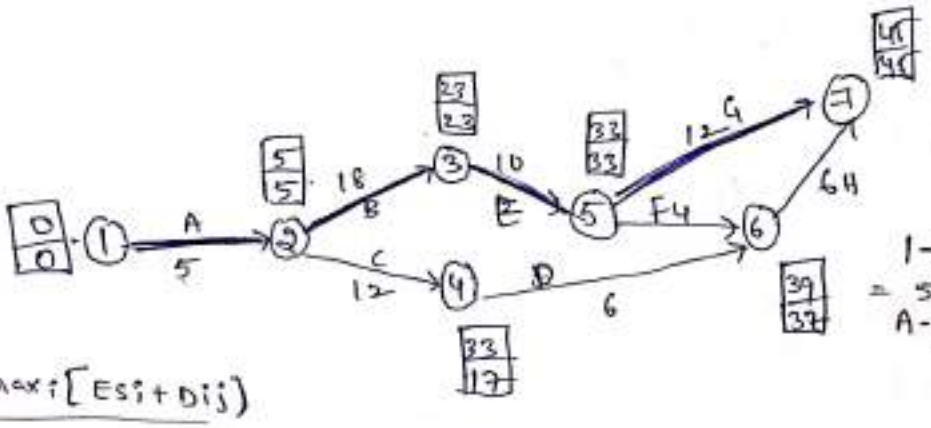
Free Float

It is the amount of time that the activity completing time can be delayed without affecting the earliest start time or immediate successor activities in the network

$$FF_{ij} = ES_j - ES_i - D$$

Note :- Any critical activities will have zero total float and zero Free float, based on this property we can determine "critical activities"

Activity		Duration	EST	EFT	LST	LFT	TF	FF
A	1-2	5	0	5	0	5	0	0
B	2-3	18	5	23	5	23	0	0
C	2-4	12	5	17	21	33	16	0
D	4-6	6	17	23	33	39	16	14
E	3-5	10	23	33	23	33	0	0
F	5-6	4	33	37	35	39	2	0
G	5-7	12	33	45	33	45	0	0
H	6-7	6	37	43	39	45	2	2



Critical path

1-2-3-5-7

= 5+18+10+12 = 45

A-B-E-G

$ES_j = \max_i [ES_i + D_{ij}]$

For Node 1 $ES_1 = 0$

Node 2 - 0+5=5

Node 3 - 0+5+18 = 23

Node 4 - 0+5+12 = 17

Node 5 - 0+5+18+10 = 33

Node 6 - 33+4 = 37

Node 7 - 33+12 = 45

$LC_i = \min_j [LC_j - D_{ij}]$

For Node 7 = LC_i = 45

Node 6 = 45-6 = 39

Node 5 = 45-12 = 33

Node 4 = 39-6 = 33

Node 3 = 33-10 = 23

Node 2 = 23-18 = 5

Node 1 = 5-5 = 0

Total Float –

$LC_j - ES_i - D_{ij}$

A – 1 – 2 = 5 – 0 – 5 = 0

B – 2 – 3 = 23 – 5 – 18 = 0

C – 2 – 4 = 33 – 5 – 12 = 16

D – 4 – 6 = 39 – 17 – 6 = 16

E – 3 – 5 = 33 – 23 – 10 = 0

F – 5 – 6 = 39 – 33 – 4 = 2

G – 5 – 7 = 45 – 33 – 12 = 0

H – 6 – 7 = 45 – 37 – 6 = 2

Free Float –

$ES_j - ES_i - D_{ij}$

A – 1 – 2 = 5 – 0 – 5 = 0

B – 2 – 3 = 23 – 5 – 18 = 0

C – 2 – 4 = 17 – 5 – 12 = 0

D – 4 – 6 = 37 – 17 – 6 = 14

E – 3 – 5 = 33 – 23 – 10 = 0

F – 5 – 6 = 37 – 33 – 4 = 0

G – 5 – 7 = 45 – 33 – 12 = 0

H – 6 – 7 = 45 – 37 – 6 = 2

PERT - Project Evaluation and Review technique

CPM - The activities timings are deterministic in nature

PERT - Each activity will have three time estimates

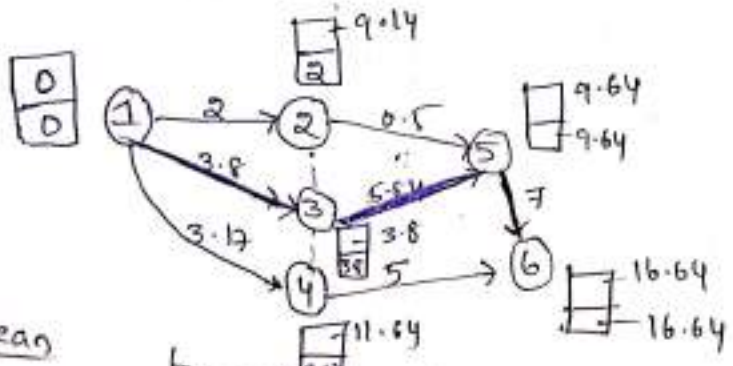
- Optimistic time
- Most likely time
- Pessimistic time

- PERT is a project management planning tool used to calculate the amount of time it will take to realistically finish a project
- PERT charts are used to plan tasks within a project, making it easier to schedule and co-ordinate team members.
- PERT which was developed by Booz Allen Hamilton & U.S. Navy
- PERT charts were created in the 1950's to manage the creating of weapons and defense projects for the U.S. Navy.
- PERT is similar to critical path in that they are both used to visualize the timeline and the work that must be done for a project

- PERT, create three different time estimates for the project

1. Optimistic time :- the shortest possible amount of time each task will take
2. Most likely time :- the most probable amount of time
3. Pessimistic time :- The longest amount of time tasks might take if things don't go as planned

Activity	Estimated Duration in weeks					
	Optimistic	most likely	Pessimistic	te	σ	σ^2
A 1-2	1	1	7	2	1	1
B 1-3	1	4	6	3.84	0.84	0.7
C 1-4	2	2	9	3.17	1.17	1.365
D 2-5	1	1	1	0.5	0	0
E 3-5	2	5	13	5.84	1.84	3.37
F 4-6	2	5	8	5	1	1
G 5-6	3	6	15	7	2	4



Mean

te - Expected duration

$$te = \frac{to + 4tm + tp}{6}$$

Activity A - $\frac{1+4\times1+7}{6} = 2$

B - $\frac{1+4\times4+6}{6} = 3.84$

C - $\frac{2+2\times4+9}{6} = 3.17$

D - $\frac{1+1\times1+1}{6} = 0.5$

E = $\frac{2+5\times4+13}{6} = 5.84$

F = $\frac{2+5\times4+8}{6} = 5$

G = $\frac{3+6\times4+15}{6} = 7$

Variance $\sigma^2 = \left[\frac{tp - to}{6}\right]^2$

For activity $A = \left[\frac{7-1}{6}\right]^2 = 1$ $\quad E = \left[\frac{13-2}{6}\right]^2 = 3.37$

$B = \left[\frac{6-1}{6}\right]^2 = 0.7$ $\quad F = \left[\frac{8-2}{6}\right]^2 = 1$

$C = \left[\frac{9-2}{6}\right]^2 = 1.365$ $\quad G = \left[\frac{15-3}{6}\right] = 4$

$D = \left[\frac{1-1}{6}\right]^2 = 0$

Standard deviation $\sigma = \frac{tp\ t_0}{6}$

$A = \frac{7-1}{6} = 1$ $\quad E = \frac{13-2}{6} = 1.84$

$B = \frac{6-1}{6} = 0.84$ $\quad F = \frac{8-2}{6} = 1$

$C = \frac{9-2}{6} = 1.17$ $\quad G = \frac{15-3}{6} = 2$

$D = \frac{1-1}{6} = 0$

→ critical path = 1 - 3 - 5 - 6

Duration = 3.8 + 5.84 + 7 = 16.64 weeks. — Next (PTO)

Exercise

Activity	Three time estimate (days)
0 - 1	2 - 3 - 10
0 - 2	4 - 5 - 6
1 - 2	0 - 0 - 0
1 - 3	6 - 7 - 8
1 - 4	1 - 6 - 9
2 - 5	3 - 5 - 19
3 - 4	0 - 0 - 0

(4) c. what is the probability that the project will be completed in 19 weeks?

	Activity	mean duration	variance
B	1-3	3.84	0.7
E	3-5	5.84	3.37
G	5-6	7	4
		16.68	8.07

$$P(x \leq 19) = P\left[\frac{x-\mu}{\sigma}\right] = P\left[\frac{19-16.68}{4.68}\right]$$

$$= P\left[\frac{2.32}{4.68}\right]$$

$$= P[Z \leq 0.495]$$

$$= 0.879$$

$$= 87.90\%$$

0.879

0.4
0.095
0.495

This value is obtained from standard normal distributing table. Therefore the probability of completing the project in 19 weeks is 0.879 i.e 87.90%.

Difference between PERT & CPM

	CPM	PERT
1.	Stands for critical path method	stands for programme evaluating and Review technique
2.	Activity Oriented	Event oriented
3.	Associated with deterministic activity	Associated with probabilistic activity
4.	Based on single time to complete	Based on three time estimates optimistic, most likely, pessimistic time
5.	No limitation of resources	Resource such as Labour, equipment material etc are limited
6.	Mainly used for construction project	Mainly used for research & development project
7.	It is a method to control costs and time	It is a technique of planning and control of time
8.	CPM is appropriate for a reasonable time estimate	PERT technique is suited for a high precision time estimate
9.	CPM involves the Job of repetitive nature	PERT is used where the nature of the Job is non-repetitive
10.	It uses dummy activities for representing sequence of activity	It does not use any dummy activity.
11.	There may be crashing because of certain time foundation	There is no chance of crashing as there is no certainty of time
12	management of predictable activities	management of unpredictable activities.

13.	critical and Non-critical activities are differentiated	critical and non-critical activity are not differentiation.

Resource levelling

- Resource levelling is a technique in which start and finish dates are adjusted based on resource limitation with the goal of balancing demand for resources with the available supply.
- Resource include the time, materials or tools needed to complete a project.
- The purpose of resource levelling to get the most out of available resources while working within the projects time, cost and scope constraints.
- Resource levelling can be challenging for project managers as it requires balancing the demand for the same resources.

Advantages

- Eliminates over-allocation
- Removes the scheduling conflicts / Risk
- Enhance productivity
- Reduces burnout

Techniques for the proper management of resources

1. The critical path technique — This technique it used for calculating the projects minimum duration, It is a way to estimate the start dates and finish dates for the project activities without consideration of the resource limitations

2. The critical chain technique – It will help you reduce uncertainty and prevent problems. This resource levelling method adds duration buffers to the entire project by including dummy activity that helps to balance out the overall path.

3. The pure Resources leveling technique – It is among the simplest resource optimizing techniques that can be used to balance the resource availability to ensure alignment with the demand for resources from the very beginning of a project.

4. Resource smoothing technique – Resource Leveling and resource smoothing are similar, resource leveling has specified limits to the project resource usage.

5. Fast tracking and crashing technique – Fast-tracking is where the activities that are supposed to run consecutively are rescheduled to run parallel.

Crashing is where extra work efforts are added in order to meet the minimum time as calculated in the critical path method.

construction claims

- A construction claim is the assertion of a right demanding either additional time or payment due to the result of an action.
- It is possible to meet construction claims in all construction projects
- clients, contractors and subcontractors of this environment try to reach their own goals and expectations in order to increase their benefits
- conflicts may arise as a result of this diversified goals and expectations of parties.
- If the conflicts are not managed successfully, disputes which affect the successful completion of the constructing project may arise

Situation causing high cost claims

From contractor

1. Inadequate site investigation before bidding.
2. Bidding below costs and over optimism
3. Slow mobilization
4. Poor planning & use of wrong equipment
5. Inadequate cost and schedule control
6. Performing defective work

From owner

1. Inadequate & ambiguous scope definition in the bid document
2. Inadequate time provided for bid preparation.
3. competitive bidding
4. major changes in the plan
5. unrealistic schedules
6. Underestimated costs

Types of construction claims to avoid

1. Injuries — when accidents happen on the construction job site, a claim is often filed against not following site safety standards.

2. change of work — This claim arises when the contractor receives a change order from the client when the project has started. The dispute occurs when the client and the contractor disagree about what does & does not fall within the scope of the contract.

3. Damage:— construction claims are also filed when construction activity causes damage to the commercial site or any adjacent property. In such cases the client suffering property damage file a claim against the contractor.

4. Schedule acceleration — Under certain circumstances, the contractors are demanded a need to exceed the budget that was agreed upon during the bidding and contract to stay on schedule. In such cases when the contractor and the client don't agree to cover the extra costs, a schedule acceleration claim is filed.

5. change in site conditions — This type of claim occurs because of differing site condition. This happens when the conditions at the construction site differ from what is specified in the contract or the actual conditions are not encountered in the area.

6. construction Defects — construction defects claim is often filed long after the contractor has finished the job. The client files the claim alleging that the contractors work has some errors that are causing issues and damage to the building or the construction property.

7. Delay — It occurs when the project takes too long to complete as opposed to what was agreed in the contract. Delay in construction results in a loss in productivity and also financial loss. [weather, pandemic, earthquakes]

Sources of claims

- The claim may arise due to the owner or the contractor. The claim may be on account of any one of the following causes.

1. There may be defects and loopholes in the contract document
2. there may be delay in release of areas as per contract. Besides, site conditions differ to a large extent from those described in the contract document.
3. The owner may desire to get the work done at a faster pace than is required by the contract document.
4. There may be delay in supply of power, water and other materials from the owner
5. There may be hold on works due to delay in release of drawings and other inputs
6. There may be delay in release of payments to the contractor
7. The scope of work may be substantially modified by the owner
8. There may be levy of liquidated damages [LD] on the contractor. other recoveries from bills may also lead to contractor raising the claim
9. There may be delay on the part of contractor in completion of works due to inadequate mobilization of labour, material and plant.

10. There may be loss of profit and investment to the owner due to delays caused by contractor.

11. Construction claims can also arise on account of inclement weather.

Claim Management

- claim management is an unavoidable process in construction project management which requires effective management practices during the entire life cycle of a project.

- claim management process basically has 4 phases as follows

1. Claim Prevention :- the claim preventing process is activated at the pre-tender and contract-formulation phases of a project. contract documents project plans and scope of work should includ all requirements related to the project because after the award of contract the opportunity to prevent claims comes to an end

2. claim mitigation :- construction activities are generally performed in highly sensitive and outdoor environments. It is better to minimize the possibilities of occuring claim all through the progression of the contract. A well defined scope, responsibili and risks will help to decrease the possibility of occurence of claims. Also risk management plans play important roles in the phase of claim mitigation

3. Pursuing claims [claim Identification and Qualification) :- claim identification can be done by analyzing both the scope of work and provisions of the contract. Inputs of the claim identification process are the scope of work, contract terms, definition of extra work and identification of extra time requested. once an activity is identified as a claim, it will be quantified interms of an additional payment or a time extension to the contract completion or other mildstone dates.

4. Claim Resolution:- claim resolution is a step by step process to resolve the claim issues. If an arrangement b/w the parties is reached, then the claim is resolved and becomes a change order. If the agreement is not reached, depending on the resolution terms of the contract the claim may proceed to negotiation, mediation, arbitration and litigation before it is completely resolved.

How to make a claim

a. claim Notification
b. claim substantiation
c. Decision of engineers / owner
d. Further action by contractor

Project closure

- This is the last phase of a construction project and is as important as any other phase in the project.
- This is a process of completing and documenting all the construction tasks required to complete the project.
- A poor project closure leaves the client unsatisfied and may prove to be a cause for not getting repeat business.
- Project closure consists of a number of tasks. This phase can be divided into the following broad headings
  a. construction closure
  b. Financial closure
  c. Contract closure
  d. Project managers closure

construction closure

- This involves preparation of the project punch list, which is a list of deficiencies identified during the combined inspection of constructed facilities by the representative of client, contractor, consultant and architect.
- During the regular inspection also, deficiencies are reported to the contractor by the architect, the consultant and the clients representative.
- The punch list is prepared usually towards the end of the project when all major construction activities are completed.
- The punch list is formally handed over to the contractor, who takes steps to rectify the deficiencies thus pointed out.
- There may be a situation in which some of the deficiencies pointed out in the punch list may not be part of the contract, the contractor in such cases usually asks the owner for extra payment.

a. Certificate of substantial completion

- For a contractor, obtaining the certificate of substantial completion is an important milestone event as it ends the contractors liability for liquidated damages [L.D]
- Substantial completion refers to a situation in which the project is sufficiently completed.
- In other words, even though some minor deficiencies may be present the constructed facility can now be used for its intended function

b. Certificate of occupancy

- This is usually issued by the municipality under whose jurisdiction the project location falls.
- It indicates that the constructed facility complies with the entire codal requirement and is safe to be occupied
- Fire and elevator-related inspection by municipal authority is required before the certificate of occupancy is issued

c. Demobilization or Release of resources

- This consists of demobilization (release) of resources such as staff and workers and is as important as their mobilization
- The closure of office, removal of unused materials lying in store and disconnecting water, electricity and sewerage lines are all part of the demobilization process.

Financial closure

- It consists of writing applications for final payment, release of various bank guarantees and settlement of any change order issued by the client

a. Final payment :- The contractor has to apply for the release of final payment after he has attended to all the deficiencies pointed out in the punch list. The request for release of retention money is also made

b. Release of various bank guarantees.

- During the course of execution of project, the contractor submits a number of bank guarantees to the owner. A written request is made to the client to release the bank guarantees.

Contract closure

- construction contract usually specifies the requirement of contract closure and thus, the contractor should prepare a list of requirements for contract closure as per the contract b/w him and the owner

a. Submission of As-built drawings

- During the project execution process, due to site constraint there might be some changes in the as built facility from that as specified in the contract drawings
- It is very important to prepare the as-built drawings by estimating the actual dimension and condition of the constructed facility
- The as-built drawings of all the trades such as civil electrical and mechanical disciplines should be compiled and submitted to the owner

b. Submission of operation and maintenance manual (4)

- Modern projects involve a number of mechanical and electrical appliances
- The manufacturers of these appliances provide operation and maintenance manual associated with these appliances.
- These should be handed over to the owner.

c. Submission of warranties

- It is the duty of the contractor to collect all the warranties and guarantees from vendors, sub contractors and suppliers and submit these to the owner

d. Submission of test reports

- During the execution of project, a number of tests are conducted on materials appliances and systems that are installed in the project
- the test records need to be compiled and submitted to the owner for future reference.

Project manager's closure

- This includes tasks such as preparation of an as-built estimate, analysis of actual cost versus estimated cost, analysis of items where cost overrun was high
- conduct of meetings with external agencies such as client, architect and consultants for understanding their feedback on various project management aspects
- meetings with own staff and subcontractors should also be held to get their feedback on various issues.

Dispute

- construction disputes arise because of disagreements b/w the parties on a contract
- Disputes can be time-consuming, harmful to a contractors reputation & damaging to the relationship b/w them and the client
- Disputes may also arise due to lack of understanding of the conditions of the contract, delays on a contract, failure to administer of the contract etc.

Common causes of construction disputes

- construction is a unique process which can giverise to some unusual and unique disputes.

a. Acceleration :- the construction costs associated with acceleration are likely to be less than the commercial risk the developer may face if key dates are missed.

b. co-ordination :- In complex projects involving many specialist trades, particularly mechanical and Electrical installations. co-ordination is key. yet conflict often arises because work is not properly co-ordinated.

c. culture :- The personnel required to visualize, initiate, plan, design, supply materials and plant-, construct, administer manage supervise, commission and correct defects throughout the span of a large construction contract is substantial. such personnel may come from different social classes or ethnic backgrounds.

d. Differing goals:- personnel engaged on a large construction contract are likely to be employed by one of many subcontracted firms. Each of these firms may have its own commitments and goals, which may not be compatible with the others and could result in disputes.

e. Delays:- Disputes frequently arise in respect of delays and who should bear the responsibility for them. most construction contracts make provision for extending the time for completion. The sole reason for this is that the owner can keep alive any rights to delay damages recoverable from the contractor.

f. Design:- Errors in design can lead to delays and additional costs that become the subject of disputes. often no planning or sequencing is given to the release of design information which then impacts on construction.

g. Quality and workmanship:- In traditional construction contracts, disputes often arise to whether or not the completed work is in accordance with the specifications.

h. Site conditions :- If the contract inadequately describes which party is to take the risk for the site conditions, disputes are inevitable when adverse site or ground conditions impede the progress of work.

i. Variations:- Variations are a prime cause of construction disputes particularly where there are a substantial number, or the variations impact on partially completed work or are issued as work is nearing completion.

Dispute Resolution

- Once a construction dispute arises, the parties to the contract may find themselves wondering what the best course of action is.
- claims can cost both parties and end up disrupting the whole project. There are things a contractor can do to avoid a dispute

Methods

1. Negotiation :- A negotiation clause basically includes the agreement that if a cause for a dispute should arise between a contractor and a project owner, these parties will attempt to reach a just and satisfactory resolution between themselves before moving on to other means.
2. Mediation :- A mediation clause suggests the inclusion of a neutral third party in the dispute situation to help mediate the process of resolving the dispute. mediation is not legally binding in anyway but can be an effective way out of a situation which could otherwise deteriorate
3. Expert determination :- An alternative to mediation is expert determination which is used to resolve disputes of a specialist nature or in cases where there is a valuation dispute requiring a specialist's opinion.
4. Adjudication :- The adjudication method also includes a neutral third party but unlike with the mediation method, the adjudicator will give a decision, whereas the mediator will assist parties in finding the resolution.

5. Arbitration :- If parties decide to go for arbitration, they will again have a neutral third party enter the situation to help resolve it. In arbitration parties agree to the arbitrator who has the relevant experience to engage in the matter. Arbitration can be legally binding, depending on the jurisdiction. The costs of arbitration can be significantly higher than that of other methods, sometimes even as high as legal proceedings.

6. Litigation :- Litigation is usually also included in the dispute clause, in case the parties do not find any other way to resolve the issues that have come up. Litigation involves a trail and is legally binding and enforceable, though it can also be appealed.

Arbitration

- Arbitration is a private, contracted form of dispute resolution.
- It provides for the determination of disputes by a third party arbitrator, selected by the parties to the dispute
- Disputes are resolved on the basis of material facts, documents and relevant principles of law.

Causes leading to arbitration

- Incorrect ground data
- Contracts containing faulty and ambiguous provisions
- Faulty administration of contract
- Deviations
- Suspension of works.
- contractor being of poor
- No publicity involved
- over payment
- Delay in payment of bills.

Advantages

- It is private - there is no public record of any proceedings, although not necessarily confidential
- Speed, although this depends very much on the manner in which the arbitrator conducts the arbitration.
- The parties can agree on an arbitrator with relevant expertise in the matter. The arbitrators award can be enforced as a judgement of the court.

Disadvantages

- The parties must bear the costs of both the arbitrator and the venue
- Sometimes arbitration simply mimics court processes and so you do not get the advantage of informality and speed.
- Limited powers of compulsion or sanction if one party fails to comply with directions of the arbitrator, which can significantly slow down the process
- Limited appeal rights
- The arbitrator has no power to make interim measures, such as for the preservation of property.

= o =

Critical Path Method: (CPM)

Formulae:

$$EST_j = [\max, (EST_i + D_{ij})]$$

$$LCT_j = \text{Min}[LCT_j - D_{ij}]$$

$$TF_{ij} = LCT_j - EST_i - D_{ij}$$

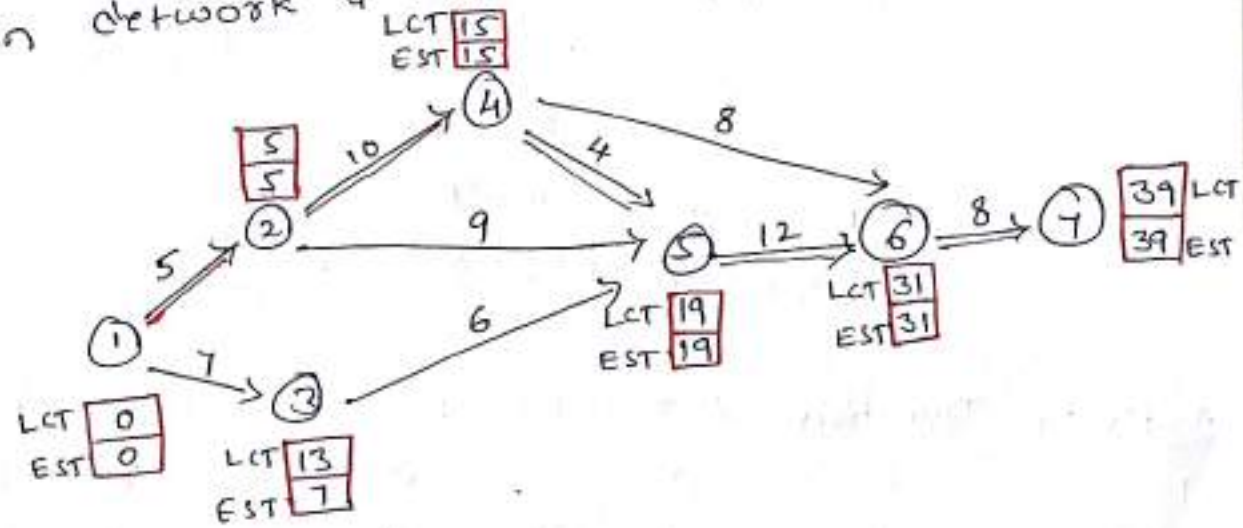
$$FF_{ij} = EST_j - EST_i - D_{ij}$$

Problem:

Activity	1-2	1-3	2-4	2-5	3-5	4-5	4-6	5-6	6-7
Duration (days)	5	7	10	9	6	4	8	12	8

Construction network & Find the critical path.

Sol:



EST

① → ② ⇒ 0, 5

i.e. ② ⇒ 0+5 = 5

④ ⇒ 5+10 = 15

③ ⇒ 0+7 = 7

⑤ ⇒ 15+4 = 19, 5+9 = 14, 7+6 = 13 } 19

⑥ ⇒ 15+8 = 23, 19+12 = 31 } → 31

⑦ ⇒ 31+8 = 39

LCT

⑦ ⇒ 39

⑥ ⇒ 39−8 = 31

⑤ ⇒ 31−12 = 19

④ ⇒ 31−8 = 23, 19−4 = 15 } 15

③ ⇒ 19−6 = 13

② ⇒ 15−10 = 5, 19−9 = 10 } 5

① ⇒ 5−5 = 0, 13−7 = 6 } 0

Activity	Duration	EST	LCT	TF	FF	Remarks
1-2	5	0	5	0	0	Cp
1-3	7	0	13	6	0	
2-4	10	5	15	0	0	Cp
2-5	9	5	19	5	5	
3-5	6	7	19	6	6	
4-5	4	15	19	0	0	Cp
4-6	8	15	31	8	8	
5-6	12	19	31	0	0	Cp
6-7	8	31	39	0	0	Cp

Critical Path

$ES_i = EC_i$; $ES_j = LC_j$ $\Rightarrow$ $ES_j - ES_i = D_{ij}$.

$LC_j - LC_i = D_{ij}$.

$T_f = F_f = 0$

1-2-4-5-6-7

$5 + 10 + 4 + 12 + 8 = 39$ days

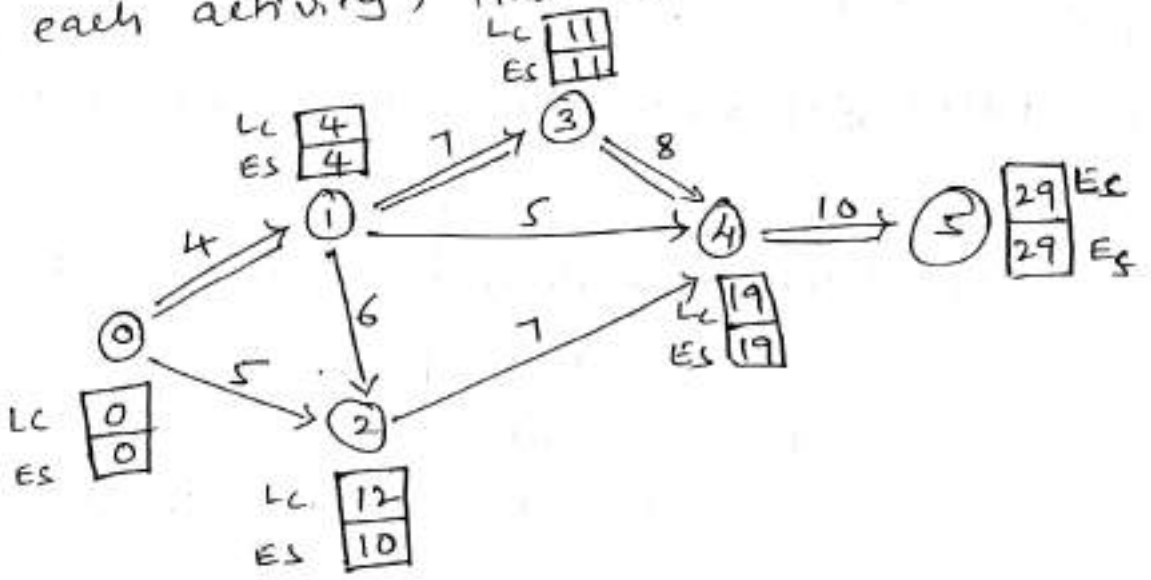
Activity	Duration	EST	EFT	LST	LFT	TF	FF	Remarks
1-2	5	0	5	0	5	0	0	Cp
1-3	7	0	7	0	13	6	0	
2-4	10	5	15	5	15	0	0	Cp
2-5	9	5	19	5	19	5	5	
3-5	6	7	19	13	19	6	6	
4-5	4	15	19	15	19	0	0	Cp
4-6	8	15	31	15	31	8	8	
5-6	12	19	31	19	31	0	0	Cp
6-7	8	31	39	31	39	0	0	Cp

Program Evaluation Review Technique [PERT] ②

Activity	Three time estimate	Estimated time (t_e) $= \frac{t_o + 4t_m + t_p}{6}$
0-1	2-3-10	4
0-2	4-5-6	5
1-2	3-6-9	6
1-3	6-7-8	7
1-4	1-5-9	5
2-4	3-5-19	7
3-4	5-6-19	8
4-5	8-10-12	10

Construction Network, Find the estimated time for each activity, find the critical path. & varience.

Sol:



Activity	Duration	EST	EFT	LST	LFT	$\sigma^2 = \left[\frac{tp-to}{6}\right]^2$	Remarks.
0-1	4	0	4	0	4	1.77	Cp
0-2	5	0	10	0	12	0.11	
1-2	6	4	10	4	12	1.00	
1-3	7	4	11	4	11	0.11	Cp
1-4	5	4	19	4	19	1.77	
2-4	7	10	19	12	19	7.13	
3-4	8	11	19	11	19	5.43	Cp
4-5	10	19	29	19	29	0.45	Cp

Critical Path

0 - 1 - 3 - 4 - 5

4 + 7 + 8 + 10 = 29 days.

If the project will be completed in 29 days, what is the ~~project~~ probability that should be completed in 32 days.

Critical activity	Duration	variance
0-1	4	1.77
1-3	7	0.11
3-4	8	5.43
4-5	10	0.45
	29	7.76

$\sigma = \sqrt{7.76} = 2.78$

$P(x \leq 32) = P\left[\frac{x-\mu}{\sigma}\right]$

$P\left[\frac{32-29}{2.78}\right]$

$P\left[1.08\right]$

i.e. $P(z \leq 1.08)$

$P(1.08) \Rightarrow 0.8599$

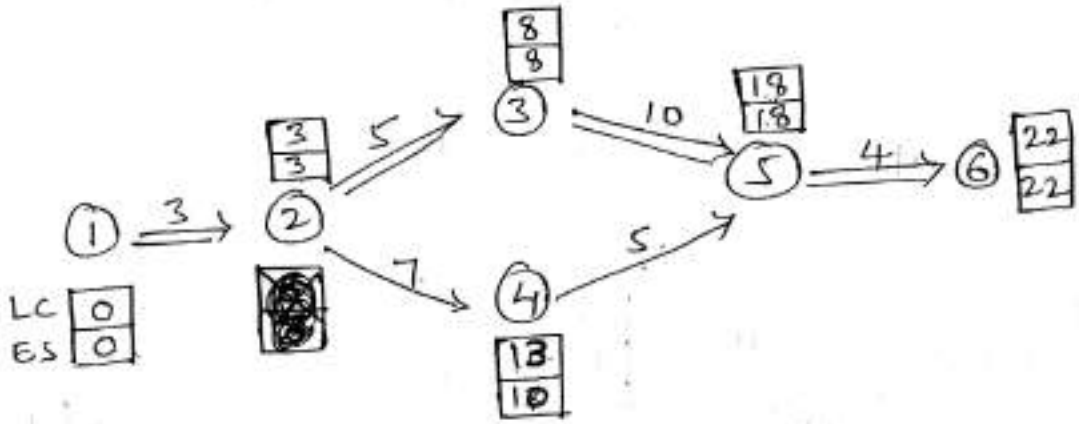
∵ From tables

85.99% ≃ 86%

Problem:

Activity	1-2	2-3	2-4	3-5	4-5	5-6
Duration	3	5	7	10	5	4

Sol:



Tabular Form

Activity	Duration	EST	EFT	LST	LFT	TF	FF	
1-2	3	0	3	0	3	0	0	cp
2-3	5	3	8	3	8	0	0	cp
2-4	7	3	10	3	13	3	0	
3-5	10	8	18	8	18	0	0	cp
4-5	5	10	18	13	18	0	3	
5-6	4	18	22	18	22	0	0	cp

Critical Path

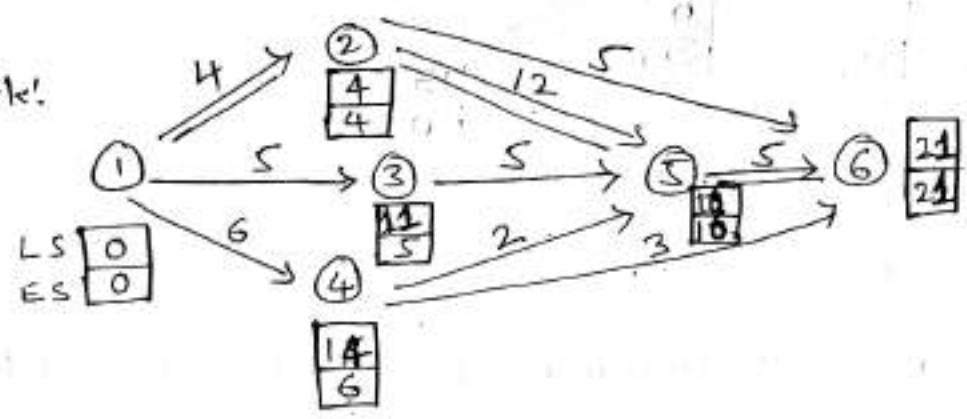
1 - 2 - 3 - 5 - 6

3 + 5 + 10 + 4 = 22 days

PERT Problem

Activity	1-2	1-3	1-4	2-5	3-5	4-5	2-6	4-6	5-6
Three time estimate	2-4-6	4-5-6	5-6-9	9-12-15	1-5-9	1-2-4	2-5-6	2-3-6	2-5-9
Duration (Days) $t_e = \frac{t_o + 4t_m + t_p}{6}$	4	5	6	12	5	2	5	3	5

Sol: Network:



Activity	Duration	EST	EFT	LST	LFT	TF	FF	σ^2
1-2	4	0	4	0	4	0	0	0.44
1-3	5	0	5	0	11	6	0	0.11
1-4	6	0	6	0	14	8	0	0.44
2-5	12	4	16	4	16	0	0	1.00
3-5	5	5	16	11	16	0	6	1.77
4-5	2	6	16	14	16	0	8	0.25
2-6	5	4	21	4	21	0	12	0.44
4-6	3	6	21	14	21	0	12	0.44
5-6	5	16	21	16	21	0	0	1.36

Date 25.3.24

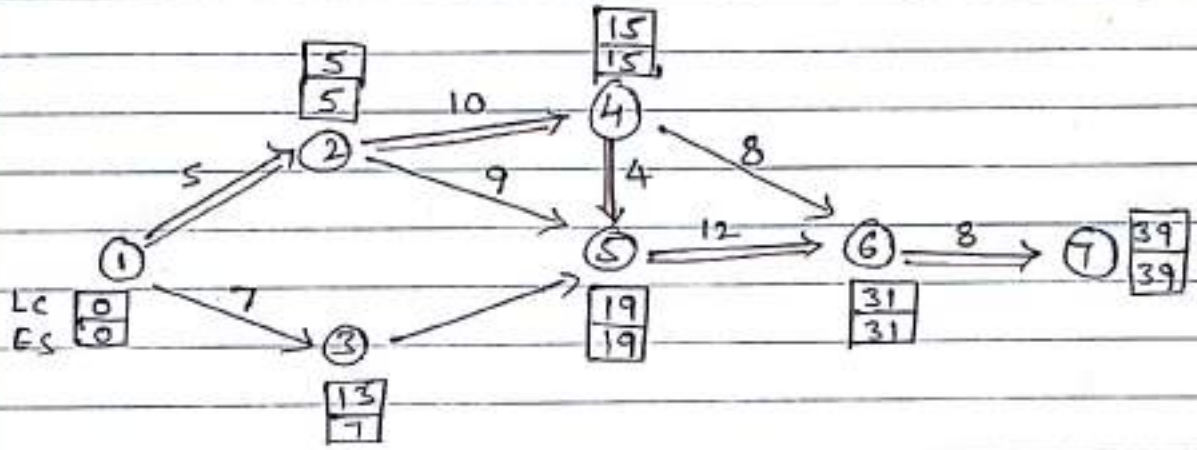
Numerical Problems on CPM & PERT

① Construct CPM Network for the following activities and find the ES, LC, TF & FF. Also find the critical path.

Acticity	1-2	1-3	2-4	2-5	3-5	4-5	4-6	5-6	6-7
Duration	5	7	10	9	6	4	8	12	8

Sol:- CPM Network:

Step-1



Step-2 Earlier start time (EST) = $[Es_i + D_{ij}]$ Max_{ij} of Activity

Latest Completion time (LCT) = $Min_{ij}[ECT_j - D_{ij}]$

1-2 $Es_i, Lc = 0, 0$ $Es_j Lc = 5, 5$
(tail end) (head end)

1-3 $Es_i, Es_j = 0, 7$; $Lc_i, Lc_j = 0, 13$

2-4 $\Rightarrow$ $Es_i, Es_j = 5, 15$; $Lc_i, Lc_j = 5, 15$

2-5 $\Rightarrow$ 5, 19; 5, 19 4-5 $\Rightarrow$ 15, 19; 15; 19

3-5 => 7, 19 ; 13, 19 4-5 -> 15, 19 ; 15, 19
5-6 => 19, 31 ; 19; 31 4-6 => 15, 19 ; 15, 19
6-7 => 31, 39; 31, 39.

Step-3 Total Float:

=) It is the amount of time that the completion time of an activity can be delayed without affecting the project completion time.

$$TF_{ij} = LC_j - ES_i - D_{ij}$$

Free Float:

It is the amount of time that the activity completion time can be delayed without affecting the earlier starting time of immediate successor activities in the network.

$$FF_{ij} = ES_j - ES_i - D_{ij}$$

Earlier Start Time: [ES]

$$ES_j = \text{Max}_{ij}(ES_i + D_{ij})$$

i => Starting activity
j => Ending activity

Latest Completion time (LC):

$$LC_i = \text{Min}_j [LC_j - D_{ij}]$$

Activity	Duration	ES	LC	TF	FF	
1-2	5	0	5	0	0	C.A.
1-3	7	0	13	6	0	
2-4	10	5	15	0	0	C.A.
2-5	9	5	19	5	5	
3-5	6	7	19	6	6	
4-5	4	15	19	0	0	C.A.
4-6	8	15	31	8	8	
5-6	12	19	31	0	0	C.A.
6-7	8	31	39	0	0	C.A.

Step-4

Critical Path : 1-2-4-5-6-7

Conditions for Critical Path

$ES_j = LC_i$ & $ES_j = LC_j$.

(or)

$ES_j - ES_i = LC_j - LC_i = D_{ij}$

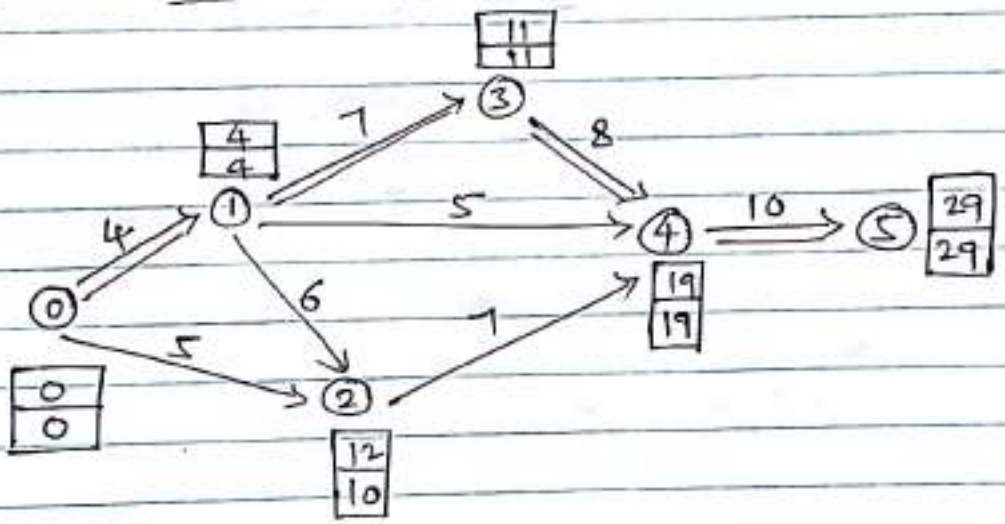
Total Duration of critical path =>

$5+10+4+12+8 = 39$

Numerical Problems on PERT

Activity	three time Estimate t_o t_m t_p	Estimated time $t_e = \frac{t_o + 4t_m + t_p}{6}$
0–1	2 – 3 – 10	4
0–2	4 – 5 – 6	5
1–2	3 – 6 – 9	6
1–3	6 – 7 – 8	7
1–4	1 – 5 – 9	5
2–4	3 – 5 – 19	7
3–4	5 – 6 – 19	8
4–5	8 – 10 – 12	10

Step-1 Construction of PERT Network:



Step-2 Finding Varience $\sigma^2 = \left[\frac{6_p - 6_o}{6}\right]^2$

0–1 $\sigma^2 = \left[\frac{10-2}{6}\right]^2 = 1.77$

0–2 $\sigma^2 = \left[\frac{6-4}{6}\right]^2 = 0.11$

1–2	$\sigma^2 = 1.00$	1–4 $\Rightarrow \sigma^2 = 1.77$
1–3	$\sigma^2 = 0.11$	2–4 $\Rightarrow \sigma^2 = 7.13$
3–4	$\sigma^2 = 5.43$	4–5 $\Rightarrow \sigma^2 = 0.45$

Tabular Form

Activity	Duration	Variance	C.A.
0-1	4	1.77	Cp
0-2	5	0.11	
1-2	6	1.00	
1-3	7	0.11	Cp
1-4	5	1.77	
2-4	7	7.13	
3-4	8	5.43	Cp
4-5	10	0.45	Cp

Critical Path:

$ES_i = LC_i$ & $ES_j = LC_j$.

0-1-3-4-5

4 + 7 + 8 + 10 ⇒ 29

What is the Probability of project completion on or before '32' days

Critical Activity	Duration	Variance
0-1	4	1.77
1-3	7	0.11
3-4	8	5.43
4-5	10	0.45
	29	$\sigma^2 = 7.76$

Total variance $\sigma^2 = 7.76$

standard deviation $\sigma = \sqrt{7.76}$

$= 2.78$

$$P(x \leq 32) = P\left[\frac{x-\mu}{\sigma}\right]$$

$$= P\left[\frac{32-29}{2.78}\right]$$

$$= P(1.08)$$

$\therefore P(z \leq 1.08) \Rightarrow 0.8599$ [From tables]

$\Rightarrow 85.99 \approx 86\%$

STANDARD NORMAL DISTRIBUTION: Table Values Represent AREA to the LEFT of the Z score.

Z	.00	.01	.02	.03	.04	.05	.06	.07	.08	.09
-3.9	.00005	.00005	.00004	.00004	.00004	.00004	.00004	.00004	.00003	.00003
-3.8	.00007	.00007	.00007	.00006	.00006	.00006	.00006	.00005	.00005	.00005
-3.7	.00011	.00010	.00010	.00010	.00009	.00009	.00008	.00008	.00008	.00008
-3.6	.00016	.00015	.00015	.00014	.00014	.00013	.00013	.00012	.00012	.00011
-3.5	.00023	.00022	.00022	.00021	.00020	.00019	.00019	.00018	.00017	.00017
-3.4	.00034	.00032	.00031	.00030	.00029	.00028	.00027	.00026	.00025	.00024
-3.3	.00048	.00047	.00045	.00043	.00042	.00040	.00039	.00038	.00036	.00035
-3.2	.00069	.00066	.00064	.00062	.00060	.00058	.00056	.00054	.00052	.00050
-3.1	.00097	.00094	.00090	.00087	.00084	.00082	.00079	.00076	.00074	.00071
-3.0	.00135	.00131	.00126	.00122	.00118	.00114	.00111	.00107	.00104	.00100
-2.9	.00187	.00181	.00175	.00169	.00164	.00159	.00154	.00149	.00144	.00139
-2.8	.00256	.00248	.00240	.00233	.00226	.00219	.00212	.00205	.00199	.00193
-2.7	.00347	.00336	.00326	.00317	.00307	.00298	.00289	.00280	.00272	.00264
-2.6	.00466	.00453	.00440	.00427	.00415	.00402	.00391	.00379	.00368	.00357
-2.5	.00621	.00604	.00587	.00570	.00554	.00539	.00523	.00508	.00494	.00480
-2.4	.00820	.00798	.00776	.00755	.00734	.00714	.00695	.00676	.00657	.00639
-2.3	.01072	.01044	.01017	.00990	.00964	.00939	.00914	.00889	.00866	.00842
-2.2	.01390	.01355	.01321	.01287	.01255	.01222	.01191	.01160	.01130	.01101
-2.1	.01786	.01743	.01700	.01659	.01618	.01578	.01539	.01500	.01463	.01426
-2.0	.02275	.02222	.02169	.02118	.02068	.02018	.01970	.01923	.01876	.01831
-1.9	.02872	.02807	.02743	.02680	.02619	.02559	.02500	.02442	.02385	.02330
-1.8	.03593	.03515	.03438	.03362	.03288	.03216	.03144	.03074	.03005	.02938
-1.7	.04457	.04363	.04272	.04182	.04093	.04006	.03920	.03836	.03754	.03673
-1.6	.05480	.05370	.05262	.05155	.05050	.04947	.04846	.04746	.04648	.04551
-1.5	.06681	.06552	.06426	.06301	.06178	.06057	.05938	.05821	.05705	.05592
-1.4	.08076	.07927	.07780	.07636	.07493	.07353	.07215	.07078	.06944	.06811
-1.3	.09680	.09510	.09342	.09176	.09012	.08851	.08691	.08534	.08379	.08226
-1.2	.11507	.11314	.11123	.10935	.10749	.10565	.10383	.10204	.10027	.09853
-1.1	.13567	.13350	.13136	.12924	.12714	.12507	.12302	.12100	.11900	.11702
-1.0	.15866	.15625	.15386	.15151	.14917	.14686	.14457	.14231	.14007	.13786
-0.9	.18406	.18141	.17879	.17619	.17361	.17106	.16853	.16602	.16354	.16109
-0.8	.21186	.20897	.20611	.20327	.20045	.19766	.19489	.19215	.18943	.18673
-0.7	.24196	.23885	.23576	.23270	.22965	.22663	.22363	.22065	.21770	.21476
-0.6	.27425	.27093	.26763	.26435	.26109	.25785	.25463	.25143	.24825	.24510
-0.5	.30854	.30503	.30153	.29806	.29460	.29116	.28774	.28434	.28096	.27760
-0.4	.34458	.34090	.33724	.33360	.32997	.32636	.32276	.31918	.31561	.31207
-0.3	.38209	.37828	.37448	.37070	.36693	.36317	.35942	.35569	.35197	.34827
-0.2	.42074	.41683	.41294	.40905	.40517	.40129	.39743	.39358	.38974	.38591
-0.1	.46017	.45620	.45224	.44828	.44433	.44038	.43644	.43251	.42858	.42465
-0.0	.50000	.49601	.49202	.48803	.48405	.48006	.47608	.47210	.46812	.46414

STANDARD NORMAL DISTRIBUTION: Table Values Represent AREA to the LEFT of the Z score.

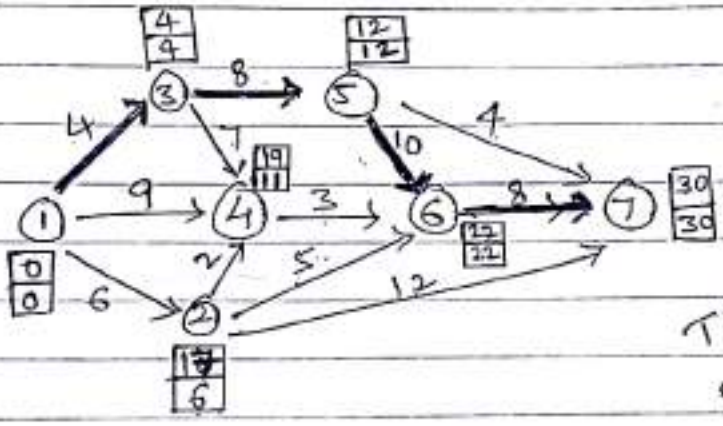
Z	.00	.01	.02	.03	.04	.05	.06	.07	.08	.09
0.0	.50000	.50399	.50798	.51197	.51595	.51994	.52392	.52790	.53188	.53586
0.1	.53983	.54380	.54776	.55172	.55567	.55962	.56356	.56749	.57142	.57535
0.2	.57926	.58317	.58706	.59095	.59483	.59871	.60257	.60642	.61026	.61409
0.3	.61791	.62172	.62552	.62930	.63307	.63683	.64058	.64431	.64803	.65173
0.4	.65542	.65910	.66276	.66640	.67003	.67364	.67724	.68082	.68439	.68793
0.5	.69146	.69497	.69847	.70194	.70540	.70884	.71226	.71566	.71904	.72240
0.6	.72575	.72907	.73237	.73565	.73891	.74215	.74537	.74857	.75175	.75490
0.7	.75804	.76115	.76424	.76730	.77035	.77337	.77637	.77935	.78230	.78524
0.8	.78814	.79103	.79389	.79673	.79955	.80234	.80511	.80785	.81057	.81327
0.9	.81594	.81859	.82121	.82381	.82639	.82894	.83147	.83398	.83646	.83891
1.0	.84134	.84375	.84614	.84849	.85083	.85314	.85543	.85769	.85993	.86214
1.1	.86433	.86650	.86864	.87076	.87286	.87493	.87698	.87900	.88100	.88298
1.2	.88493	.88686	.88877	.89065	.89251	.89435	.89617	.89796	.89973	.90147
1.3	.90320	.90490	.90658	.90824	.90988	.91149	.91309	.91466	.91621	.91774
1.4	.91924	.92073	.92220	.92364	.92507	.92647	.92785	.92922	.93056	.93189
1.5	.93319	.93448	.93574	.93699	.93822	.93943	.94062	.94179	.94295	.94408
1.6	.94520	.94630	.94738	.94845	.94950	.95053	.95154	.95254	.95352	.95449
1.7	.95543	.95637	.95728	.95818	.95907	.95994	.96080	.96164	.96246	.96327
1.8	.96407	.96485	.96562	.96638	.96712	.96784	.96856	.96926	.96995	.97062
1.9	.97128	.97193	.97257	.97320	.97381	.97441	.97500	.97558	.97615	.97670
2.0	.97725	.97778	.97831	.97882	.97932	.97982	.98030	.98077	.98124	.98169
2.1	.98214	.98257	.98300	.98341	.98382	.98422	.98461	.98500	.98537	.98574
2.2	.98610	.98645	.98679	.98713	.98745	.98778	.98809	.98840	.98870	.98899
2.3	.98928	.98956	.98983	.99010	.99036	.99061	.99086	.99111	.99134	.99158
2.4	.99180	.99202	.99224	.99245	.99266	.99286	.99305	.99324	.99343	.99361
2.5	.99379	.99396	.99413	.99430	.99446	.99461	.99477	.99492	.99506	.99520
2.6	.99534	.99547	.99560	.99573	.99585	.99598	.99609	.99621	.99632	.99643
2.7	.99653	.99664	.99674	.99683	.99693	.99702	.99711	.99720	.99728	.99736
2.8	.99744	.99752	.99760	.99767	.99774	.99781	.99788	.99795	.99801	.99807
2.9	.99813	.99819	.99825	.99831	.99836	.99841	.99846	.99851	.99856	.99861
3.0	.99865	.99869	.99874	.99878	.99882	.99886	.99889	.99893	.99896	.99900
3.1	.99903	.99906	.99910	.99913	.99916	.99918	.99921	.99924	.99926	.99929
3.2	.99931	.99934	.99936	.99938	.99940	.99942	.99944	.99946	.99948	.99950
3.3	.99952	.99953	.99955	.99957	.99958	.99960	.99961	.99962	.99964	.99965
3.4	.99966	.99968	.99969	.99970	.99971	.99972	.99973	.99974	.99975	.99976
3.5	.99977	.99978	.99978	.99979	.99980	.99981	.99981	.99982	.99983	.99983
3.6	.99984	.99985	.99985	.99986	.99986	.99987	.99987	.99988	.99988	.99989
3.7	.99989	.99990	.99990	.99990	.99991	.99991	.99992	.99992	.99992	.99992
3.8	.99993	.99993	.99993	.99994	.99994	.99994	.99994	.99995	.99995	.99995
3.9	.99995	.99995	.99996	.99996	.99996	.99996	.99996	.99996	.99997	.99997

Problem:

Activity	1-2	1-3	1-4	2-4	2-6	2-7	3-4	3-5	4-6	5-6	5-7	6-7
Duration (Days)	6	4	9	2	5	12	7	8	3	10	4	8

Construct the CPM Network & Find EST, EFT, LST, LFT, TF, FF & Critical Path.

Sol: Nodes



TF = LFT − EST − Dij

FF = EFT − EST − Dij

Activity	Duration	EST	EFT	LST	LFT	TF	FF	Remarks
1-2	6	0	6	0	17	11	0	
1-3	4	0	4	0	4	0	0	CA
1-4	9	0	11	0	19	10	2	
2-4	2	6	11	17	19	11	3	
2-6	5	6	22	17	22	11	11	
2-7	12	6	30	17	30	12	12	
3-4	7	4	11	4	19	08	0	
3-5	8	4	12	4	12	0	0	CA
4-6	3	11	22	19	22	8	8	
5-6	10	12	22	12	22	0	0	CA
5-7	4	12	30	12	30	14	14	
6-7	8	22	30	22	30	0	0	CA

Critical Path conditions

EST = LST

EFT = LFT

TF = FF → '0' &

LFT - LST = EFT - EST = Duration.

by identifying the path.

1 - 3 - 5 - 6 - 7

4 + 8 + 10 + 8 = 30 days.