CONSTRUCTION PLANNING AND SCHEDULING

CONSTRUCTION TIME PLANNING

1. PROJECT CONSTRUCTION PLANNING

Project construction planning includes the following inter-dependent components:

- *Construction Time Planning & Scheduling*
- *Resources and Cost Planning & Scheduling*

2. CONSTRUCTION TIME PLANNING AND SCHEDULING

Construction Time Planning is the first step in the construction planning process. It includes the planning effort required to facilitate timely completion of a project. Construction Time Scheduling provides a working time-table of project activities for completion of the project within specified time. It is a direct consequence of the construction time planning process.

The steps involved in construction time planning and scheduling process are:

1. Develop Project Work Breakdown Structures (WBS)
2. Develop Activity List
3. Estimate Activity Durations
4. Establish Activity Logic Relationships
5. Define Project Base Calendars
6. Develop Project Time Schedule
7. Analyze and Adjust Project Time Schedule

Steps 1-5 will be covered in this handout. Steps 6-7 will be covered in next handout.

Detailed Explanation of Construction Time Planning And Scheduling steps using Real-Time Construction Project - 100 Unit Housing Colony (Refer Lectures 12 ~ 15).

Step 1. Project Work Breakdown Structures (WBS):

1.1 Key Idea

WBS provides the foundation for defining work as it relates to project objective and establishes the structure for managing the work to its completion.

A WBS is not a to-do list (consisting of everything that needs to be done on the project). Rather it is management structure.

1.2 WBS Definition

According to PMI:

> A Work Breakdown Structure (WBS) is a deliverable-oriented grouping of project components that defines and organizes the total scope of the project; work not in the WBS is outside the scope of the project.

Stated in another way, a WBS is the hierarchy of work you must accomplish to complete a project. The WBS is structured in levels of work detail, beginning with the end result or product, and then divided into identifiable work elements. Each descending level in a WBS represents an increasingly detailed description of the project deliverables.

These definitions imply that a WBS has the following characteristics:

1. It is representative of work, and this work has a tangible result.
2. It is arranged in a hierarchical structure.
3. It provides a management structure.

1.3. WBS Levels

The WBS will include all work to be done by the primary organization. While generally the WBS consists of a five-level hierarchy describing the entire effort to be accomplished by the primary organization, that number may not be appropriate for all situations. The depth of a WBS is dependent upon the size and complexity of the project and the level of detail needed to plan and manage it.

The WBS levels may be broadly categorized into five major levels. These levels, arranged in a descending hierarchical order are:

Level 1: Program level

Level 2: Project level

Level 3: Task level

Level 4: Sub-Task Level

Level 5: Work Package level

A WBS is normally presented in chart form (see Fig. 1).

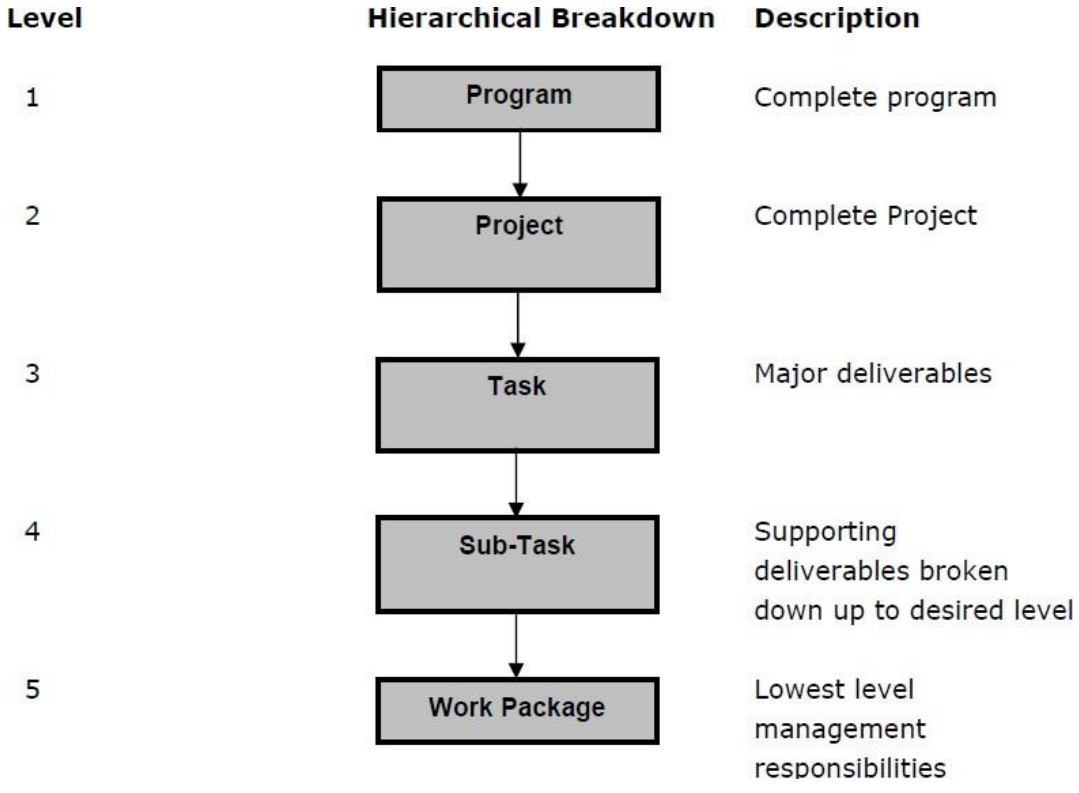


Fig. 1. Hierarchical Chart for WBS

The upper three levels of the WBS are normally specified by the client (as part of an RFP - Request For Proposal) as the summary levels for reporting purposes. The lower levels are generated by the Contractor for in-house control.

Project Control Levels	WBS Levels
Project Management	Program/ Project
Intermediate Managerial Levels	Task/ Sub-Task
Supervisor Levels	Work Package

Fig. 2. Project Control and WBS Levels

1.3.1. Program and Project Levels:

Program level defines the overall work program. A work program consists of two or more inter-related projects with overall time, cost and performance objectives and resource constraints. Each group of major works which can progress in a systematic manner, with minimal interference from other works, and which produces a major deliverable can be treated as a project. Each project is assigned time, cost and performance objectives and is provided with planned resources for accomplishing the project objectives. In the 100 Housing Units Residential Colony Project, each category of construction (Categories A to D) can be treated as a project (see Exhibit 2) while the whole work can be treated as a program.

The number of projects in a program varies with the nature and complexity of the program. Note that each project may comprise of one or more contract packages.

1.3.2. Task and Sub-Task Levels: A **task** represents a higher level significant work output within a project (for example, feasibility report which marks phase end deliverable for the feasibility phase of a project). Each task can further be decomposed in **sub-tasks** (for example, EIA study report, benefit-cost analysis report, etc). This hierarchical structure of task / sub-tasks establishes a management structure with desired level of management control at each level of project work.

1.3.3. Work Package Level:

According to PMI:

"A Work Package is defined as a deliverable at the lowest level of the work breakdown structure, when that deliverable may be assigned to another (work) manager to plan, execute and control." This may be accomplished by further decomposing each work package into activities.

There is an important difference in the last work breakdown structure level and an activity. Typically, a work package includes the outcomes of more than one activity from more than one department/ area of work. Therefore, the work package does not have duration of its own and does not consume resources and cost directly; the resources and cost for the work package are simply the summation of the resources and costs for all the activities constituting the work package.

Note that the lowest element of a WBS is a work package, which represents the lowest management responsibility level desired on the project, which in turn represents the level of trust in the management team.

Exhibit 1 shows a simplified WBS for the housing colony project.

1.4. Uses and Effectiveness of WBS

1. **Represents complete scope of work in an organized manner.**
2. **Sorts work in a hierarchical order.**
3. **Identifies major deliverables and sub-deliverables.**
4. **Develops a list of work packages.**
5. **Thought process tool**. WBS helps the PM and the project team visualize exactly how the work of the project can be defined and managed effectively.
   Alternative ways of decomposing the work will be considered until an alternative is found with which the PM is comfortable.
6. **Strategy Design tool**. WBS is a picture of the work of the project and how the items of work are related to one another.
7. **Management database at various Levels.**
8. **Structuring of work organization.** While WBS is developed, organizations, organizational units, teams and individuals are assigned responsibility for accomplishment of work components.
9. **Integration tool**. WBS supports integrating responsibility for the various works with various responsibility units (organizations, departments, teams, individuals) by having a direct relationship between the WBS elements related to the *Organizational Breakdown Structure (OBS)* identified through the *Responsibility Assignment Matrix (RAM).*
10. **Work Budgeting.** WBS can be used for budget allocation on individual work components. Using the project roll-up approach, this budget allocation can be consolidated into establishing the overall project budget requirement.
11. **Planning tool**. Using the lowest work package level of the WBS, time, resource and cost requirements of constituting activities are estimated; a work schedule is prepared; and deliverable dates and project completion are estimated.
12. **Monitoring and Reporting tool**. Use of structure provides the opportunity to "roll up" (sum) the budget and actual costs of the smaller work items into larger work elements so that performance can be measured by organizational units and work accomplishment. These performance measurements can then be reported to senior management at various levels in the project organization.
13. **Communication tool.** WBS defines communication channels and assists in understanding and coordinating many parts of the project. The structure shows the work and organizational units responsible and suggests where written communication should be directed. Problems can be quickly addressed and coordinated because the structure integrates work and responsibility.

1.5. WBS Development Procedure

Project WBS development is based on a technique called *decomposition*. Decomposition involves subdividing work into smaller, more manageable components arranged in a hierarchical order until the work is defined in sufficient detail to facilitate management control as well as development of project activities. WBS development involves the following major steps:

Step 1: Identify the projects in the program, if any. The projects should be defined in terms of independent major physical products of the program.

Step 2: Identify the major deliverables of each project. The major deliverables should always be defined in terms of how the project will actually be organized and managed. There are two approaches to be considered: **noun-type approaches** and **verb-type approaches**.

> **Noun-type approaches** define the deliverable of the project work in terms of the physical components that make up the deliverable.
> For example: the physical units (*areas* - A1, A2, A3; *sections* - M1, M2, M3; *building blocks* - Admin, CED, MED, Library)
> **Verb-type approaches** define the deliverable of the project work in terms of the actions that must be done to produce the deliverable.
> For example: the phases of the project life cycle (design, procurement, construction, handover), or the work specialty (civil, mechanical, HVAC, etc.).

Step 3: Decompose major deliverables to a level of detail appropriate for management and integrated control. Decide if adequate cost and duration estimates can be developed at this level of detail for each deliverable. For each deliverable, proceed to step 5 if there is adequate detail, to step 4, if not – this means that different deliverables may have different levels of decomposition.

Step 4: Identify constituent components of each deliverable (these are the subdeliverables or sub-tasks). As with deliverables, sub-deliverables should be described in terms of tangible, verifiable results to facilitate performance measurement. Divide until criteria in step 3 is achieved. Now you are at workpackage level.

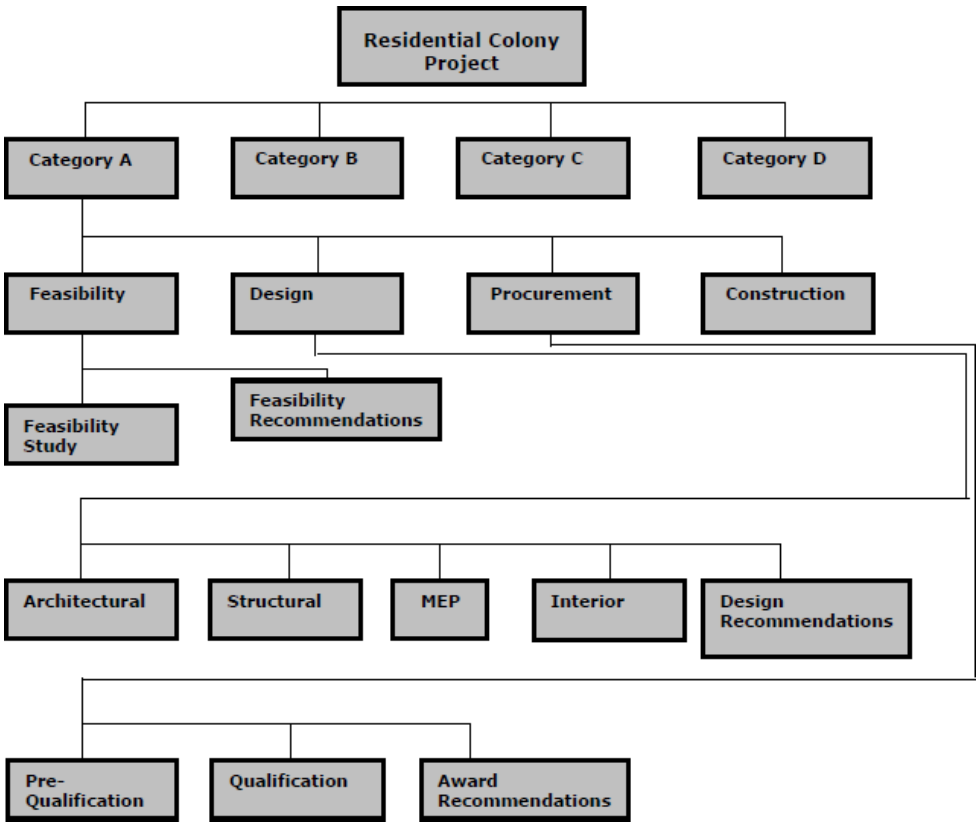
Every effort should be made to develop a WBS that is output-oriented in order to concentrate on concrete deliverables. If a WBS follows the organizational structure, the focus will be on the organization function and processes rather than the project output or deliverables.

1.6. WBS for the 100 Housing Unit Residential Colony Project

Exhibit 1 shows a sample WBS for the 100 Housing Unit Residential Colony Project. Note that this is not the only way to organize a WBS on this type of project. (*what other ways are possible?*).

Exercise 1: The WBS in Exhibit 1 is not completely decomposed. After going through the next section (Activity List), refer back to this WBS and develop the missing levels.

Exhibit 1. Work Breakdown Structure for Housing Colony Project



Step 2. Develop Activity List:

2.1 Activity

An activity is an identifiable and measurable short duration task that has a definite start and stop point, consumes resources and represents cost.

Each activity is a control point. An Activity Manager is responsible for seeing that the activity is completed on time, within budget and according to technical specifications.

The resources and cost for a work package are simply the summation of the resources and costs for all the activities constituting the work package. Thus, the **activity is the basic unit used for planning, monitoring and controlling the project.**

2.2. Activity Definition

Activity definition involves identifying and documenting the specific activities that must be performed in order to produce the work packages identified in the work breakdown structure.

2.2.1. Inputs to Activity Definition

- *Work breakdown structure*. Identification of work elements
- *Historical information.* What activities were actually required on previous, similar projects
- *Constraints*. Factors that will limit the project team's work options. These constraints may include: national economic policies, land reclamation constraints, unavailability of sophisticated equipment for site investigation and/or implementing construction methodologies.
- *Assumptions.* Factors that, for planning purposes, will be considered to be true, real, or certain.

2.2.2. Technique for Activity Definition

- *Decomposition of WBS work packages.*

2.2.3. Output from Activity Definition

- *Activity list*. The activity list must include all activities that will be performed on the project. A well prepared activity list allows the project team to separate out all activities of each trade, as well as identify the activity types (see section 2.3).

  A sample activity list developed for a Category D house (single storey normal finish house) of the residential colony project is shown in Exhibit 2.
- *Supporting Details.* Supporting details for the activity list should include documentation of all identified assumptions and constraints. For instance, if during excavation water tends to come out then it should be clearly mentioned as to whether or not the pumping of water is included within the scope of the project.

Exercise 2: The Activity List in Exhibit 2 does not include any hammock activity. Include at least two hammock activities in the list.

2.3. Activity Types

- *According to Nature of Activity*
- *According to Planning Consideration*

I. According to Nature of Activity

1. Production Activities

Production activities define the actual physical construction of the project.

Examples are:

- Erect concrete columns,
- Run electrical conduits, or

- Install sanitary fixtures.

If the project is composed of multiple units, floors, areas or sections, the activity would designate the activity location, such as run electrical conduits, 1st Floor.

2. Procurement Activities

Activities can also be categorized as procurement or purchasing activities. These are the activities that need to occur to get all of the materials, equipment and manpower to the job site. Bid procurement activities are also included

Examples are:

- Order tile,
- Approve flooring sample, or
- Prepare structural steel connection shop drawing
- Pre-qualify contractors

Most material procurement activities follow a logical sequence:

1. *Preparation of the submittal by the supplier or subcontractor;*
2. *Approval of the submittal by the owner and/or designer*
3. *Ordering and fabrication of the work item and*
4. *Delivery of the item to the job site.*

3. Administrative Activities

The third category of activity is the administrative activity. An activity the duration of which depends upon the logic and relationships existing between it and the various other activities is referred to as a hammock activity.

Examples are:

- Inspection activities by local officials or federal or regulatory agencies,
- Approval activities such as land approval and acquisition, or presentation before an architectural review commission,
- Management activities such as design or construction supervision.
- Identifying these activities is going to require the involvement of all the principal parties, since normally no single party knows all of the administrative steps that have to be followed. The construction team would be able to define the construction-related inspections, such as rough and finish plumbing inspections. The designer would identify any design reviews by third parties, such as those for seismic zoning requirements. The owner would be principally involved in securing financing and approvals for the project. The project/construction manager would be responsible for most, if not all, of the management activities.

4. Milestone Activities

A key event in the life of a project can be identified by the use of a milestone activity. Examples are:

- The prearranged shutdown of plant operations,
- The delivery of a certain floor of a building to a tenant, or
- A road to be opened by a specific date.

Unlike an activity, a milestone cannot be assigned to a responsibility unit and does not consume time or resources. A milestone is used to signify an important point in the life of a project so as to "flag" significant project accomplishments serving as a measure of project performance. For instance, delivery of a certain floor of a building to a tenant is an Intermediate milestone.

Commonly used milestones are the Start Milestone (e.g. Project Start) and the Finish Milestone (e.g. Project Handover).

II. According to Planning Considerations

1. **Task (fixed duration)** *"scheduling of activity determines scheduling of resources"*
   The assigned resources on the activity should be scheduled according to the activity's schedule.
   For example, several activities must be done in the week before the completion of house. It doesn't matter whether the resources are available earlier than that week, or whether they will otherwise be scheduled for time off during that week - these activities must be scheduled during a specific time-period, and their scheduling controls the scheduling of their resources. Major construction activities fall in this category.
2. **Resource Driven**
   "scheduling of activity is determined by the scheduling of resources"

   In some cases, resource availability is highly constrained.

   For instance, a contractor has access to excavator for only three days in a week. This may be because he is sharing the excavator on another project. In such a case, all excavation activity on the project must be scheduled within the available days of excavator.
3. **Hammock**
   "No specific duration, duration is calculated on the basis of relationships"

   Duration of some activities cannot be estimated using first principles.
   For instance, what could be the duration of construction supervision? The answer is: It depends on the period of construction i.e. when the contract is awarded and when the project is handed over.

   Can you identify a few more hammock activities?

Exhibit 2. Structured Sample Activity List for Residential Colony Project

WBS Levels	Activity	Activity Type 1 (Nature)	Activity Type 2 (Planning)
1. Feasibility			
1.1. Feasibility Study			
	Project Start	Milestone	Milestone
	Need Analysis	Production	Task
	Benefit/ Cost Analysis	Production	Task
	EIA	Production	Task
1.2. Feasibility Recommendations			
	Feasibility report preparation	Production	Task
	Analysis of feasibility report	Production	Task
	Yes/ No Decision	Milestone	Milestone
2. Design			
2.1. Architectural Design			
	Architectural Layout	Production	Task
	Architectural Design	Production	Task
2.2. Structural Design			
	Structural Layout	Production	Task
	Structural Design	Production	Task
2.3. MEP Design			
	Preliminary Design	Production	Task
	Detailed Design	Production	Task
2.3. Interior Design			
	Preliminary Design	Production	Task
	Detailed Design	Production	Task
2.4. Design Recommendations			
	Submission of Drawings & Specs	Production	Task
	Design Review	Production	Task
	Design Approval	Milestone	Milestone

WBS Levels	Activity	Activity Type 1 (Nature)	Activity Type 2 (Planning)
3. Bid Procurement			
3.1. Contractor Pre-Qualification			
	Receiving Pre-qualification	Procurement	Task
	Analysis of Pre-qualification	Procurement	Task
	Selection of pre-qualified	Procurement	Task
3.2. Contractor Qualification			
	Tender Floating	Procurement	Task
	Tender Analysis	Procurement	Task
	Tender Negotiations	Procurement	Task
3.3. Contractor Award Recommendations			
	Contract Terms and Conditions	Procurement	Task
	Award of Contract	Milestone	Milestone
4. Construction			
4.1. Preparatory Works			
	Mobilization	Production	Task
	Site Clearance	Production	Task
	Site Layout and Preparation	Production	Task
4.2. Civil Structural Works			
4.2.1. Sub-Structure Works			
	Excavation	Production	Task
	Foundations	Production	Task
	Stub Columns	Production	Task
	Plinth Beams	Production	Task
	UGWT	Production	Task
4.2.2. Super-Structure Works			
	Columns	Production	Task
	Beams/ Slabs	Production	Task
	OHWT	Production	Task
4.3. MEP Works			
4.3.1. Preliminary			
	Rough Electrical	Production	Task
	Rough Plumbing	Production	Task
4.3.2. Finishing			
	Electrical Fittings	Production	Task
	Plumbing Fixtures	Production	Task
4.4. Civil Finishing Works			
4.4.1. Internal Works			
	Block Masonry	Production	Task
	Door/ Window Frames	Production	Task
	Plaster	Production	Task
	Door/ Window Panels	Production	Task
	Flooring	Production	Task
	Paint	Production	Task
4.4.2. External Works			
	Block Masonry	Production	Task
	Plaster	Production	Task
	Fixing of Main Gate	Production	Task
	Paint	Production	Task
5. Handover			
	Punch List	Production	Task
	Project handover	Milestone	Milestone

Step 3. Estimate Activity Durations:

Activity duration estimating involves assessing the **work time** likely to be needed to complete each identified activity

Duration for every activity is needed so that planning of the project can be done with respect to time.

3.1 CONCEPT

- ***Work Time (Duration):*** Work time is the business time required to complete an activity. This does not include weekends, holidays, or other non-work time, but includes provision for any anticipated interruptions.
- ***Calendar Time***: Calendar time is the total time required to complete an activity considering the work as well as non-work periods, and including provision for any anticipated interruptions.

For example, a client has an activity that requires him to send a document to a government agency, where it would be reviewed, approved, and then returned. The client has done this on several previous occasions, and it normally took about 10 business days before the document was back in client's office. The government agency works for 5 days in a week and the client is sending the document on Monday morning. Now:

a. What is the duration? The answer is 10 days.

b. What is the calendar time? The answer is 12 days (Mon-Fri, Sat, Sun, Mon-Fri).

3.2. ESTABLISHMENT OF ACTIVITY DURATION

Activity duration can be estimated with the aid of a computer (e.g., by using excel spreadsheet or project management software) or with manual techniques.

Manual techniques are often more effective on smaller projects. Manual and automated techniques may also be used in combination.

3.3. INPUTS TO ACTIVITY DURATION ESTIMATION

- ***Quantity of Work***: The amount of work that needs to be performed; e.g. 10,000 cft of excavation, 2000 cft of concreting, 1000 sq-ft of block masonry, etc. This information is obtained from detailed BOQ or work estimates in conjunction with construction drawings.

- ***Execution Methodology***: The execution methodology drives the resource requirement on the activity. For example, the activity of placing concrete in the foundation of a large building can be done in any of the following ways - manually, using crane and bucket arrangement, pumping by concrete pumps or transporting by a conveyor system. The time and cost for each of these methods will differ considerably. The choice of the method of execution of an activity depends upon the past experience, the market availability of appropriate resources, the resources available with the contractor, the technological and methodological constraints, and the cost-benefit analysis of the various methods of production. In short, it is the method of production that dictates the resources required for accomplishment of an activity.

- ***Resource Requirement***: What type of resources (manpower, equipment and material) are required and in what quantity? Resource estimates are normally made using the planning norms developed from:
  - Organizational records of previous projects
  - Project team knowledge and experience
  - Commercially available databases (if any)
  - Expert advice

- ***Resource Productivities:*** The capabilities of the humans and equipment resources assigned to activities - e.g. if both are assigned full-time, a senior staff member can generally be expected to complete a given activity in less time than a junior staff member. Resource productivity is normally determined from:
  - Organizational records of previous projects
  - Project team knowledge and experience
  - Commercially available databases (if any)
  - Expert advice
  - Field research

  Note that lack of focus, temperature variation, untimely breaks, socializing, coordination issues, rework due to errors, lack of supervision, etc. account for reduced resource work input in a work day. *Average productivity is usually taken at 65-75% of maximum productivity*.

- ***Time Contingency:*** This includes any possible time variation that needs to be incorporated for any anticipated and unanticipated interruptions, e.g. Interruptions might include a phone call with a question to be answered, an equipment breakdown, power interrupts, random events of nature, untimely delivery of material, bad weather forecasts, absenteeism, strikes, etc. Few of these interruptions may be anticipated (e.g. bad weather forecast, procession, strike etc.) while others may be unanticipated (e.g. random event of nature).
  About one-third of the time is normally spent on interruptions.

3.4. TECHNIQUES FOR ACTIVITY DURATION ESTIMATION

The following techniques can be used for initial planning estimates:

- One-time estimate
- Three-times estimate

- ***One-time estimate*** In most of the construction works, it is generally possible to assess the duration of an activity with reasonable certainty by using organizational planning data records, experience, commercially available databases, or expert advice. **The one-time estimate for activity durations is usually used for Production activities.**

$$\text{Duration of an activity} = \frac{\text{Quantity of work}}{\text{Production Effort}}$$

where,

Production Effort = Number of resource teams x productivity of each resource team

Example

How many hours will be needed to excavate 10,000 cu-ft with the provided data?

Excavator's Productivity = 1000 cu-ft/hr

Number of Excavators = 2

Contingency factor =0.2

Duration = $\frac{^{5}\cancel{10,000}}{1000 \times 2}$ cu ft / hr = 5 hours

Now, adjust for contingency:

Adjusted Duration = 5 x 1.2 = 6 hours

If the number of excavators increases from 2 to 4, will the duration become 6 hours?

- ***Three-time estimate***

For this method you are calling on the collective memory of professionals who have worked on similar activities but for which there is no recorded history, or if there is a recorded history, the current conditions are too different.

Here activity duration is considered a random variable, which means that if it were possible to repeat the activity several times under identical circumstances, duration times would vary. That variation may be tightly grouped around a central value, or it might be widely dispersed.

To use three-time estimate technique, three estimates of activity duration: optimistic, pessimistic, and most likely (See Fig. 3.) are needed. The optimistic time is defined as the shortest duration one has or might expect to experience given that everything happens as expected. The pessimistic time is that duration that would be experienced (or has been experienced) if everything that could go wrong did go wrong and yet the activity was completed. Finally, the most likely time is that time usually experienced (most expected).

The following relation is used to calculate the expected duration of such an activity:

$$Te = \frac{a+4m+b}{6}$$

where, Te = expected activity duration

a = optimistic time, b = pessimistic time, m = most likely time

The three-time estimate is usually used for some types of Procurement and Administrative activities. It can effectively be used in certain areas of construction projects where major uncertainty in duration estimation exists.

Some of these are as follows:

- The sanctioning of a government project
- The necessary project approvals
- The feasibility stage of a project

- The closeout stage of a project
- Procurement of long-lead items

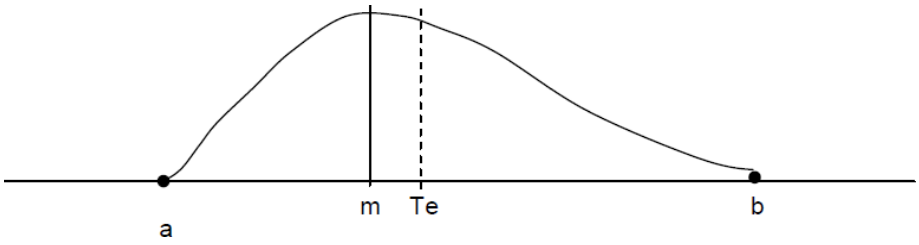


Fig. 3. Three-Time Estimate

Example: Consider the activity of sanctioning of a government project. It has to pass through many channels and depends upon many factors.

Assume that the sanction is most likely to take 8 weeks, and if all goes well, the earliest it can happen is 6 weeks, but in any case, it will certainly come through in 16 weeks. The expected duration of the activity can then be calculated as follows:

$$Te = \frac{6+(4 \times 8)+16}{6} = 9 \text{ weeks}$$

3.5 ACTIVITY DURATION ESTIMATION PROCEDURE

Duration of each activity is evaluated independent of the others. The various stages in duration estimation of a construction activity can be identified as follows:

1. Estimating the quantity of work. These estimates are worked out from the engineering drawings and BOQ of the project.
2. Assessing the employment of resources. Based on the execution methodology, assess the resources that can be employed effectively. Normally, in construction, resources are employed in teams.
3. Deciding the labor and equipment productivity. These values vary with place, environment and projects. If resources are employed as teams, this step means deciding resource team productivities.
4. Estimating the activity duration - one-time or three-time.
5. Rounding up the duration to nearest value.
6. Making duration adjustments for any anticipated or unanticipated contingency.

3.6. Output from Activity Duration Estimating

Activity duration estimates. Quantitative assessments of the likely number of work periods required for completing an activity.

For the residential colony project, the activity duration estimates for a Category D house are shown in Exhibit 3.

Basis of estimate. Documentation of the assumptions used for developing the estimates.

Activity list updates

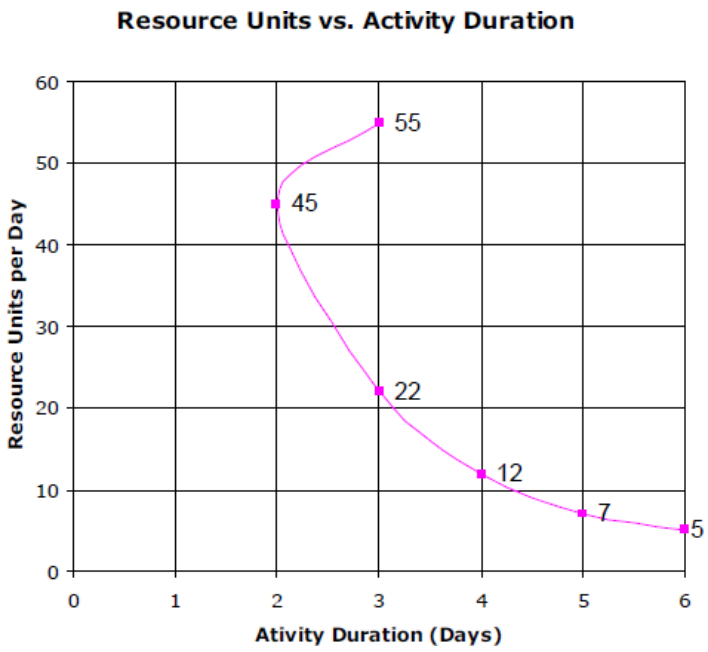
Exhibit 3. Activity Duration Estimates for a Category D House

Activity ID	Activity	Duration
1	Project Start	0
2	Need Analysis	14
3	Benefit/ Cost Analysis	21
4	EIA	14
5	Feasibility report preparation	21
6	Analysis of feasibility report	7
7	Yes/ No Decision	0
8	Architectural Layout	14
9	Architectural Design	21
10	Structural Layout	14
11	Structural Design	21
12	Preliminary MEP Design	7
13	Detailed MEP Design	14
14	Preliminary Interior Design	7
15	Detailed Interior Design	14
16	Submission of Drawings & Specs	7
17	Design Review	7
18	Design Approval	0
19	Receiving Pre-qualification Documents	14
20	Analysis of Pre-qualification Documents	14
21	Selection of pre-qualified contractors	7
22	Tender Floating	14
23	Tender Analysis	14
24	Tender Negotiations	14
25	Contract Terms and Conditions	7
26	Award of Contract	0
27	Mobilization	14
28	Site Clearance	7
29	Site Layout and Preparation	7
30	Excavation	14
31	Foundations	14
32	Stub Columns	7
33	Plinth Beams	7
34	UGWT	14
35	Columns	7
36	Beams/ Slabs	21
37	OHWT	21
38	Rough Electrical	14
39	Rough Plumbing	14
40	Electrical Fittings	21
41	Plumbing Fixtures	21
42	Block Masonry – Internal	21
43	Door/ Window Frames	14
44	Plaster – Internal	28
45	Door/ Window Panels – Internal	7
46	Flooring	28
47	Paint – Internal	14
48	Block Masonry – External	7
49	Plaster – External	7
50	Fixing of Main Gate	7
51	Paint – External	14
52	Punch List	14
53	Project handover	0

3.7. ACTIVITY DURATION AND RESOURCE VARIATION

- *There are diminishing returns for adding more resources.*
- *There is a maximum loading of resources on an activity to minimize the activity duration, and that by adding another resource you will actually begin to increase, the duration.*
- *There is a minimum loading of resources needed on an activity or else it can not be performed*
- *There is not necessarily an (inverse) linear relationship between the amount of resource assigned to an activity and its duration.*

Fig. 4 shows what the four points identify.



Explanation of above four points:

Duration of an activity is influenced by the amount of resources scheduled to work on it. Adding more resources to hold an activity duration within the planning limits can be effective. This is called crashing an activity. For example, suppose you are in a room where an ordinary size, four-legged chair is in the way. The door to the room is closed. You are asked to pick up the chair and take it out of the room into the hallway. You might try to do it without any help, in which case you would perform the following steps:

1. Pick up the chair;
2. Carry it to the door;
3. Set the chair down;
4. Open the door;
5. Hold the door open with your foot as you pick up the chair;
6. Carry the chair through the door and
7. Set the chair down in the hallway.

Suppose you double the resources. We'll get someone to help you by opening the door and holding it open while you pick up the chair and carry it out to the hallway. With two people working on the activity, you'd probably be willing to say it would reduce the time to move the chair out into the hall.

Doubling the resources sounds like a technology breakthrough in shortening duration. Let's try doubling them again and see what happens.

Now, we've got four resources assigned to the activity. The activity would go something like this: First, you hold a committee meeting to decide roles and responsibilities. Each person would like to get equal

credit, so each one grabs a leg of the chair and tries to go through the door, but they all get stuck in the door. (By the way, there's nobody left to open the door because each of the four resources is dedicated to one leg of the chair.)

You have reached the crash-point of the activity. The crash-point is that point where adding more resources will increase activity duration. *The project manager will have to consider the optimum loading of a resource on an activity.*

Another consideration for the project manager is the **amount of reduction in duration that results from adding resources**. The relationship is not linear. Consider the chair example again. Does doubling the resource cut the duration in half? Can two people dig a hole twice as fast as one? Probably not. The explanation is simple. By adding the nth person to an activity, you create the need for n more communication links.

Who is going to do what? How can the work of several people be coordinated? There may be other considerations that actually add work. To assume that the amount of work remains constant as you add resources is simply not correct. New kinds of work will emerge from the addition of a resource to an activity. For example, adding another person adds the need to communicate with more people and increases the duration of the activity.

A last consideration for the project manager is the **impact on risk from adding another resource**. If we limit the resource to people, we must consider the possibility that two people will prefer to approach the activity in different ways, with different work habits, and with different levels of commitment. The more people working on an activity, the more likely one will be absent, the higher the likelihood of a mistake being made, and the more likely they will get in each other's way.

3.8. HOW AND WHERE TO ACCOUNT FOR CONTINGENCIES

Increase the durations of those activities that control the project (critical activities) and that are likely to be affected during the life of the project.

3.9. IMPORTANT GUIDELINES FOR ACTIVITY DURATION ESTIMATION

1. Activity duration estimation should be done preferably, by the person responsible for its performance.
2. Each activity should be evaluated independently of all the others. For a given activity, assume that materials, labor, and equipment will be available when required and in whatever amounts required (Recall task).
3. Duration estimation should be based on the preferred method of execution considering current practices and prevailing work conditions.

4. Assume that activity will be performed in an organized manner.
5. For each activity, assume a normal level of manpower and equipment. Based on experience and research, normal/ standard crew size can be defined.
6. A normal workday (usually 8 hours/ day) is assumed. Overtime or multiple shifts are not considered unless this is standard procedure or part of a normal work-period.
7. Use consistent time units throughout (workhours, workdays, shifts, workweeks, workmonths, etc.).
8. Expert judgment guided by historical information should be used whenever possible. Durations are often difficult to estimate because of the number of factors that can influence them (e.g., resource type and number, resource productivity).
9. Time contingencies and practical problems should be considered, because we are not living in PERFECT WORLD.
10. A minimum and maximum limit on activity durations allow for effective monitoring:
    - A larger duration activity (e.g. "build foundation") would undoubtedly simplify the project plan, but it wouldn't be very helpful in controlling the work.
    - A smaller duration activity (e.g. "place rebar # 1000") would maximize the effort necessary to create and update the project plan, while providing maximum control in the construction work.
    - In practice, we look for a compromise.

Step 4: Establish Activity Sequencing/ Logic Relationships

Activity sequencing involves identifying interactivity dependencies/ relationships. Activities must be sequenced accurately in order to facilitate development of a realistic and achievable schedule.

4.1. ESTABLISHMENT OF ACTIVITY SEQUENCING

Sequencing can be performed with the aid of a computer (e.g., by using project management software) or with manual techniques. Manual techniques are often more effective on smaller projects. Manual and automated techniques may also be used in combination.

4.2. INPUTS TO ACTIVITY SEQUENCING

- ***Activity list***
- ***Mandatory dependencies (Hard Logic)***

  Mandatory dependencies are those that are inherent in the nature of the work being done. They often involve physical limitations. In a road project, for instance, placing of base course is impossible without sub base placing.
- ***Discretionary dependencies (Soft/Preferred Logic)***

Discretionary dependencies are those that are defined by the project management team based on knowledge of:

- "Best practices".
- Some unusual aspect of the project where a specific sequence is preferred even though there are other acceptable sequences.

- ***External dependencies***

  External dependencies are those that involve a relationship between project activities and non-project activities. For example, environmental hearings may need to be held before site preparation can begin on a project.

- ***Constraints***
- ***Assumptions***

4.3. TECHNIQUES FOR ACTIVITY SEQUENCING

To depict the logic dependencies amongst activities, a project network diagram is developed using either the Arrow Diagramming Method or the Precedence Diagramming Method.

4.3.1. Arrow Diagramming Method (ADM)

A project network drawn using ADM is built up from three main symbols:

- full arrows that represent activities;
- nodes that correspond to events and
- dummy arrows for logical sequences.

This technique is also called activity-on-arrow (AOA) diagramming method.

ADM can be done manually or on a computer. Fig. 5 which shows a simple project network diagram drawn using ADM is based on the given project data.

Activity ID	Predecessor
A	-
B	A
C	B, D
D	-
E	D
F	E

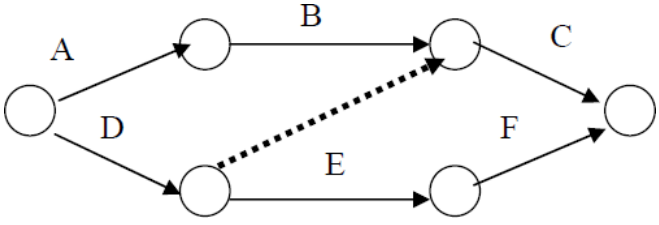


Fig. 5. Network Logic Diagram Drawn Using ADM

Important Terms to Identify:

Predecessor (Preceding Activity) →Activity immediately before

Successor (Succeeding Activity) →Activity immediately following

Important parts of an ADM/AOA Network:

- A full arrow shows an activity and hence must have an ID and duration.
- The start and finish of an activity are events; they are represented as numbered circles called nodes. An event represents the achievement of a certain stage in the development of a project. It is defined as 'a state (a moment in time) in the progress of a project after the completion of all preceding activities but before the start of any succeeding activity.'
- The length of an arrow has no significance: it is not drawn to scale.
- The direction of arrow shows the direction of the activity in time, the arrowhead indicating the end of the activity.
- The term start event means an event with succeeding but no preceding activities and end event means an event with preceding but no succeeding activities.
- Some events may represent "milestones" which indicate that they have some particular significance to the planner. Usually the start, the finish and the completion of major phases of the project will be called milestones.
- **Dummies:** Dummies are activities with zero time duration represented by broken arrows. The standard definition of dummy is 'a logical link, a constraint which represents no operation.' It is used for one or more of the following:
    - To express logic i.e. sequence of events (Fig. 6.a);
    - To provide a unique numbering for each activity i.e. to prevent two or more activities from having the same i (start node) and j (end node) numbers (Fig. 6.b). (This is particularly required when developing th e ADM on computer) and
    - To ensure a single start event and a single end event for a project network (Fig. 6.c).

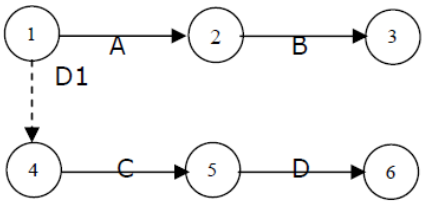


Fig. 6.a. Logic Dummy

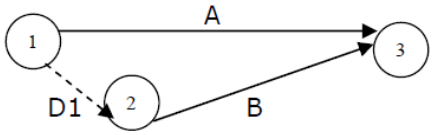


Fig. 6.b. Numbering Dummy

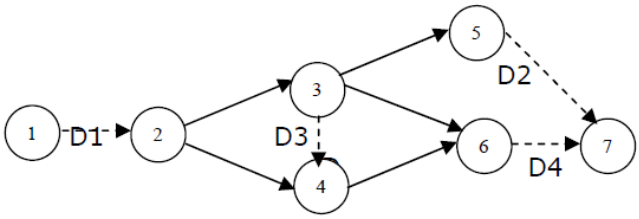
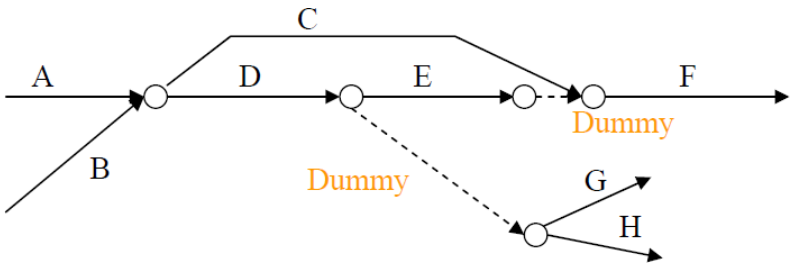


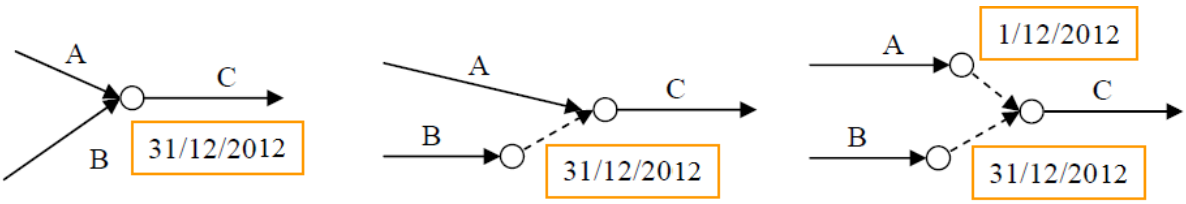
Fig. 6.c. Start or Finish Dummy

Using dummies efficiently

1. Avoid redundant dummies when dependencies are clear



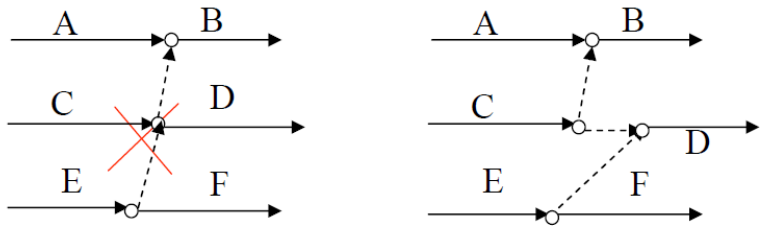
2. For clarity in defining some milestones



What does this milestone mean? What if the milestone is for B? What if the milestones are for A and B both?

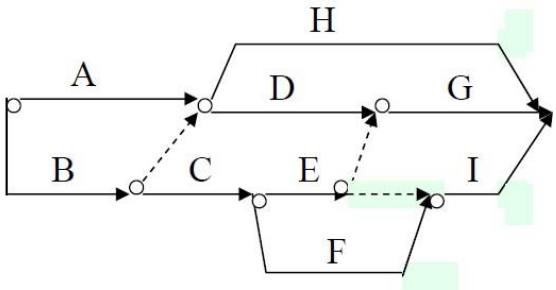
Using dummies to resolve dependencies
Example 1:

Activity	Succeeding activities
A	B
C	B and D
E	D and F



Example 2:

Activity	Succeeding activities
A	D, H
B	C, D, H
C	E, F
D	G
E	G, I
F	I



ADM Activity Relationship:

ADM only uses Finish-to-Start (FS) activity relationship.

- FS Activity starts when predecessor has finished
- Most commonly used relationship
- Default relationship for all project management software
- For instance, column starts when foundation has finished.

Example Project Network using ADM Diagramming: Consider part of a project in which a square footing is to be built as shown in Fig. 7.

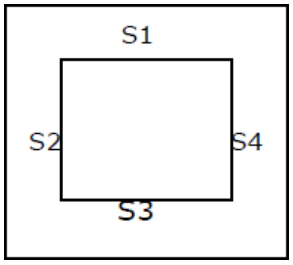


Fig. 7. A Wall Footing

This requires the following items of work (activities):

Activity ID	Activity Description	Duration (Workdays)
A	Excavate	8
B	Build and Place Formwork	4
C	Place Rebar	4
D	Place Concrete	4

The ADM network for this part of the project is shown in Fig. 8.a.

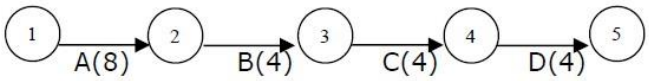


Fig. 8.a. ADM for Footing

From this example, it can clearly be seen that letting the work to proceed on more than one activity at a time would allow for efficient management of time, resource and budget.

After side S1 is excavated, S2 can be excavated while S1 is being formed. Later, the rebars can be placed for S1 while S2 is being formed and S3 is being excavated, and so on.

Defining activities in smaller units allow overlapping of activities.

Revised activity list:

Activity ID	Activity Description	Duration (Workdays)
A1	Excavate S1	2
B1	Form S1	1
C1	Place Rebars for S1	1
D1	Place Concrete for S1	1
A2	Excavate S2	2
and so on...		

The revised ADM network for this part of the project is shown in Fig. 8.b.

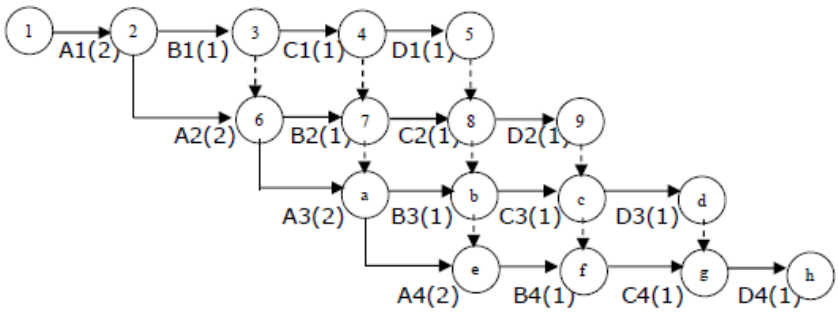


Fig. 8.b. Arrow Diagram (Revised)

Advantages of ADM/ AOA Network:

- It consists events. Events can be used to depict milestones. Efficient use of dummies can allow precise identification of milestones.
- The main advantage of ADM diagrams is the realistic approach of having arrows to represent activities that endure in time, whereas nodes (equivalent to points) l show the points in time at which activities begin and end.

Disadvantages of ADM/ AOA Network:

- Arrow notation uses an implicit finish-to-start relationship between dependent activities; i.e. when all arrows entering a node are complete, all arrows leaving may start. Two activities, such as the installation of reinforcing steel in a slab and the addition of conduits and other inserts in the same slab, may be required to be performed concurrently, but the network schedule would probably be able to show them only as being performed in parallel, with their starts requiring the completion of previous activity(s) and their completions constraining the beginning of later work. Or, the network might resort to showing the activities in sequence, with steel placement first, followed by conduit placement; such a representation may only be partially correct, with a small amount of steel actually being installed prior to start of conduit installation. In nearly all cases, it is simply impractical to break the project into so many detailed components as would allow reality to be depicted exactly. Actually, the finish-start constraint, while being unrealistic at times, does not cause us any unsolvable problems, but it does require us to be more careful in defining our activities and generally causes an unnecessarily larger number of activities to be needed for a given project.
- There can be no time lapse between the finish of preceding activity and start of succeeding activity; since nodes are events in time with zero duration.
- Finish-to-start constraint in ADM may require the use of dummy activities to define all logical relationships correctly. This makes the network unnecessarily complex as well as error prone.

4.3.2. Precedence Diagramming Method (PDM)

This is a method of constructing a project network diagram using:

- nodes to represent activities and
- full arrows to show the dependencies.

Fig. 9. shows a simple project network diagram drawn using PDM. This technique is also called activity-on-node (AON) and is the method of choice for most project management software packages (*why?*). Like ADM, PDM can be done manually or on a computer.

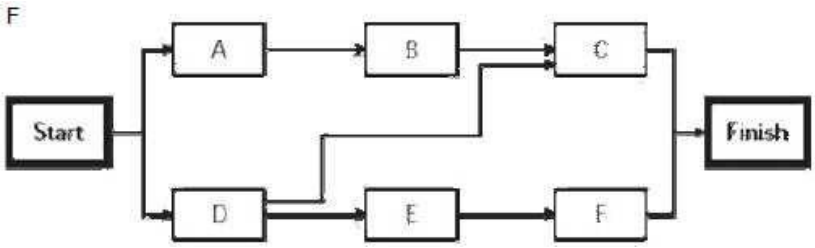


Fig. 9. Network Logic Diagram Drawn Using PDM

Do you think Figs. 5 and 9 represent the same project network? Which one seems to be a better representation and why?

Important parts of a PDM/AON Network:

- In a PDM diagram, a node - the "rectangular box", represents an activity and the "links" - the arrows, connect activities.
- Dummies can be forgotten, almost. Only a starting or ending dummy will be used, if needed, to ensure that there is a single start and a single finish activity for the project.

Precedence Relationships:

In an actual construction project, especially fast track projects, many activities have relationships that are not easily expressed with traditional **Finish-to-Start logic** which requires that one activity must finish before the following one can start. To overcome this limitation presented by ADM, PDM allows for four types of dependencies or **precedence relationships**. This gives more flexibility and ease in realistically identifying and defining the activity relationships, thereby allowing for a better model of the construction process. Unlike the traditional Finish-to-Start logic, all precedence relationships allow for activity overlapping and hence are most useful in fast track projects.

How can we overlap activities?

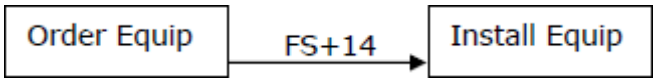
Activities can be overlapped by using four precedence relationships - Finish-to-Start (FS), Start-to-Start (SS), Finish-to-Finish (FF) and Start-to-Finish (SF).

Precedence Relationships with Lead-Lag Factor:

Any of the precedence relationship between two activities may require specification of a time lead or a time lag in order to accurately define the relationship. PDM, in addition to using different relationships, allows use of lead-lag factors to indicate the amount of time that must expire before the action expressed by the relationship can be performed.

For instance, in the traditional FS relationship, an activity can start immediately when predecessor has finished - this is equivalent of a lead lag factor of 0 because zero time was **required** between finish of first activity start of latter. In precedence diagramming, we can assign a lead-lag factor of any real number (even a percentage of duration).

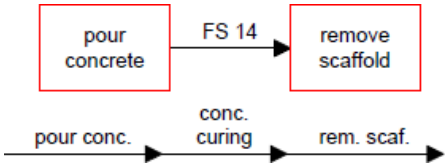
A positive value of lead-lag factor means a lag i.e. "wait", whereas a negative value indicates a lead. A zero value for the lead-lag factor represents **no time lapse needed** between two activities. For example, the planning team desires that there should be at least a two-week lapse between ordering a piece of equipment and installing it. This relationship may be represented as follows:



Explanation of Precedence Relationships:

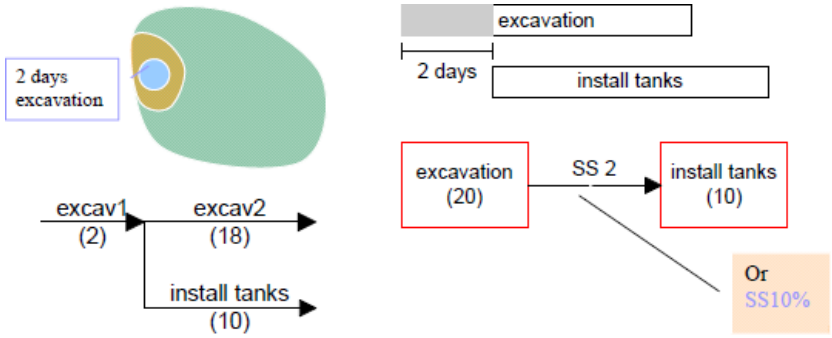
1. Finish to Start

- Traditional I-J relationship
- Succeeding activity cannot start until minimum time has lapsed after the preceding activity has been completed



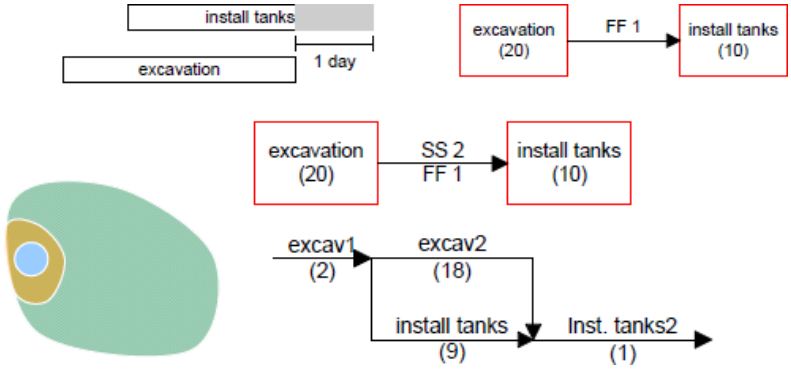
2. Start to Start

Minimum time that must be completed on the preceding activity prior to start of successor



3. Finish to Finish

- minimum time that must remain to be completed on succeeding activity after completion of predecessor



4. Start to Finish

- minimum time that must transpire from start of predecessor to completion of successor
- Note that this relationship is ***not the reverse of Finish to Start***.

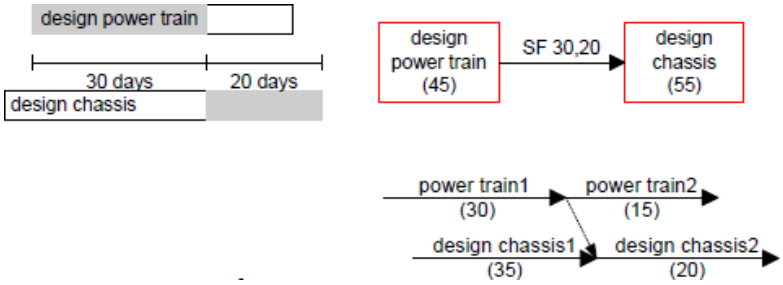
Example:

- To complete chassis design (55 days) requires:

  preliminary design of power train (30 days)

  takes another 20 days

  Power train design can proceed as usual (45 days)



Important comment on precedence relationships:

Any precedence relationship (with or without lead-lag factor) always specifies a lower bound of time. *Can you interpret the following relationships between A and B?*

1. FS B can start at the same time or any time after finish of A
2. FS+7 B can start at least 7 days after finish of A
3. SS+2 B can start at least 2 days after start of A
4. FF+30 B can finish at least 30 days after finish of A
5. FS-3 B can start at least 3 days prior to the finish of A
6. SF+3 B can finish at least three days after start of A

Example Project Network using PDM/ AON Diagramming:

Consider the same square footing as was shown in Fig. 5. The PDM network for the same part of the project is given in Fig. 10.b.

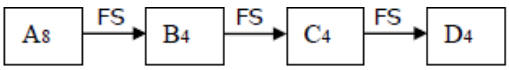


Fig. 10.a. Conventional AON Diagram for Footing

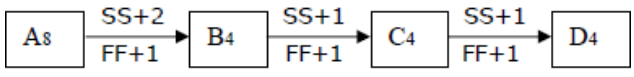


Fig. 10.b. PDM Diagram for Footing

Do you think PDM Diagram is a more efficient and realistic representation of the project network (as compared to conventional network)?

Advantages of PDM Network:

- Dummies are eliminated. Learning the significance and proper usage of dummies requires time and experience and besides increasing complexity, dummies may lead to false dependencies that are a real hazard.
- It is a more realistic model for construction process as it allows for multiple logic relationships: start-start, finish-start, finish-finish and start-finish.
- The arrow that connects two activity nodes can have a time duration. This feature tends to reduce the number of activities that must be included in the network by allowing relationships in addition to "finishstart" and lead-lag factor.
- Many managers agree that concept of activity-on-node is easier to grasp than that of activity-on-arrow network. It is also easier to modify and correct a node diagram than an arrow diagram.
- Each activity can be assigned a single unique number, which can be used to classify the work by cost code, location, and the like.

Disadvantages of PDM Network:

- Events - point in time represented by circles on an activity-on-arrow network - are eliminated, and for some projects events are of major importance (recall that events may represent milestones).
- The main drawback of Node diagrams is the confusion caused by having symbols (equivalent to points) to represent activities that endure in time, whereas lines show the points in time at which activities begin and end.

Final Comments on Arrow and Node Networks:

- The method for developing the network in either of the two cases is somewhat different.
- The final networks should represent same project logic, since the beginning and ending times for each activity and the project logic is obviously independent of the kind of network representation technique used.

4.4. OUTPUTS FROM ACTIVITY SEQUENCING

- ***Project network diagram.*** A project network diagram is a schematic display of the project's activities and the logical relationships (dependencies) among them.
- ***Activity list updates.*** Dividing or redefining activities so that the relationships are correctly diagrammed.

Step 5: Define Project Base Calendars

A base calendar defines the work period of a project organization. *Project Base Calendars cumulatively define the working and non-working periods of the project activities with respect to the performing organization(s).*

Do we need more than one calendar for a single project?

Yes!

Why?

Any construction project normally involves a number of organizations working on it. For instance, for the residential colony project under consideration, the following organizations may be involved:

- Architect/ Design Consultant
- Construction Management Firm
- General Contractor
- Sub Contractor 1 for finishing works
- Sub Contractor 2 for Mechanical, Electrical and Plumbing (MEP) works etc.

Each organization has its own working or non-working periods.

For example, see Table 1.

Table 1: Workdays for parties involved in a construction project

Calendar	Party	Work Period
1	General Contractor	7 Day Workweek (Mon – Sun)
2	Sub Contractor 1	7 Day Workweek (Mon – Sun)
3	Sub Contractor 2	6 Day Workweek (Mon – Sat)
4	Arch. & Design Consultant	5 Day Workweek (Mon – Fri)
5	Construction Mgmt Firm	7 Day Workweek (Mon – Sun)

- *Which calendar we will use for an activity?*

  The calendar for the performing organization of that activity.

Note that Work Calendars can be different for:

- Organizations involved in the project
- Resources
- Activities

Note that each party may also have its designated holidays (non-work periods); for instance, national day, independence day, other company designated holidays, etc. Some of these non-work periods may be common among the various companies involved while some may belong to specific organizations only.

Schedule of work performed by an organization will be based on the base calendar of that organization. More on this will be discussed later.

Project base calendars provide the mechanism for converting work time to calendar time.

QUESTION WITH ANSWERS

DEPARTMENT : CIVIL **SEMESTER: V**

SUB NAME: CONSTRUCTION PLANNING AND SCHEDULING

UNIT- 1 CONSTRUCTION PLANNING

(PART A- 2MARKS)

1. What is planning? **(AUC May/June2012)**

Planning aims at formulation of a time based plan of action for coordinating various activities and resources to achieve specified objectives. Planning is the process of developing the project plan. The plan outlines how the project is to be directed to achieve the assigned goals. It specifies a predetermined and committed future course of action, based on discussions and decisions made on the current knowledge and estimation of future trends.

2. What is construction planning

The construction planning process is stimulated through a study of project documents. These documents include but are not limited to the available technical and commercial studies and investigations, designs and drawings, estimation of quantities, construction method statements, project planning data, contract documents, site conditions, market survey, local resources, project environment and the client's organization. The planning process takes in to account, the strengths and weakness of the organizations.

3. What are the objectives of planning?

- Proper design of each element of the project
- Proper selection of equipment and machinery in big projects, the use of large capacity plants are found economical
- Procurement of materials well in advance
- Proper arrangement of repair of equipment and machinery
- Employment of trained and experienced staff on the project
- To provide incentive for good workers
- To arrange constant flow of funds for the completion of project
- To provide proper safety measures and ventilation, proper arrangement of light and water.

4. What are the types of project plans?

Planning the entire project from its inception to completion requires a vast coverage, varied skills and different types of plans. The nature of plans encountered in a typical construction project are indicated below

Types of project plans

Development stage - nature of plan

Inception stage - project feasibility plan
Engineering stage - project preliminary plan
Implementation stage - project construction plan

5. Define work tasks? (AUC May/June2012)

Work tasks represent the necessary frame work to permit scheduling of construction activities, along with estimating the resources required by the individual work tasks and a necessary precedence or required sequence among the tasks. The terms work tasks or activities are often used interchangeably in construction plans to refer to specific defined items of work.

6. List out the project planning techniques?

Stages	Planning process	Techniques/methods
Planning time	Breaking down project work, developing time network plans	Work break down, network analysis, gnat chart
Planning resources	Forecasting resource requirements, planning manpower requirements, planning material requirements, budgeting costs, designing organizational structure	Man power scheduling Material scheduling Resource allocation Cost planning & budgeting Equipment selection and scheduling
Planning implementation	Formulating monitoring methodology	Resource productivity control, time control, contribution control, budgetary control

7. What are the steps involved in planning? (AUC May/June2012)

1. Defining the scope of work to be performed
2. Preparing the logic or network diagram to establish a relationship among activities and integrating these diagrams to develop the network model
3. Analyzing the project network or models to determine project duration, and identifying critical and non-critical activities
4. Exploring trade-off between time to cost to arrive at optimal time and costs for completing the project.
5. Establishing standards for planning and controlling men, materials, equipment, costs and income of each work package
6. Forecasting input resources, production costs and the value of the work done
7. Forecasting the project budget allocations for achieving targets assigned to each organizational unit
8 Designing a control system for the organization
9 Developing the resources, time and cost control methodology.

8. What is the purpose of coding? (AUC May/June2013)

1. To identify the data connected with each work package, as work packages from the database for managing various project functions.
2. To aid in the organization of data from the very detailed to the very broad levels
3. To enable the processing, sorting, and extraction of information required at various levels of management and functional units.
4. To computerize the data processing system

9. How many categories available in codification?

In construction projects, the codes used can be broadly divided in to two categories i.e. project interfacing codes or simply referred as project codes and department specialized codes.

Project interface codes:

These are the common codes used for developing an inter department database. Ex: a project code for the foundation of a building.

Departmental specified codes:

These codes are developed by the departmental heads for their use.

Ex: to indicate the location of materials in site ware houses

10. Define the types of labeling approach?

a. alphabet codes

b. numerical codes

c. alphanumeric codes

Alphabet codes:

Alphabet letters A to Z, single or combined, can be used to represent a code. An alphabet in a single character space can represent 26 variations as compared to numerals 0 to 9, which can depict maximum of 10 variations

Numerical codes:

It is the most important form of coding in numerical codes, each character can be represented by a numerical varying from 0 to 9

Alpha numerical codes:

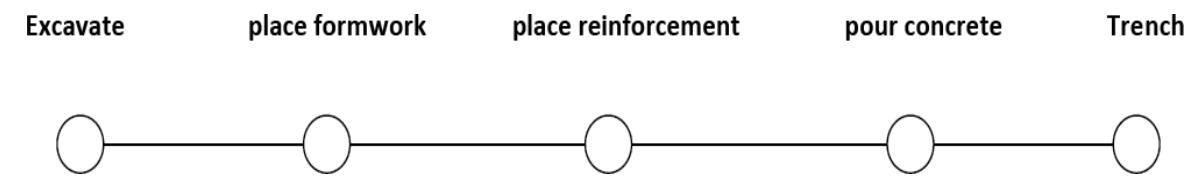
It is the combination of alphabets and numerals to develop a each code.

11. Defining precedence relationship among activities?

Precedence relations between activities signify that the activities must take place in a particular sequence. Numerous natural sequences exist for construction activities due to requirements for structural integrity, regulations and other technical requirements.

For example

Excavate place formwork place reinforcement pour concrete
Trench



12. Define the following terms? **(AUC May/June2009)**

i. activity

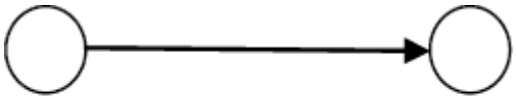
ii. event

Activity: a project can be broken down in to various operations and process necessary for its completion. Each of these operations and processes, which consume time and possibly resources, is called activity. The activities are represented by arrows.

For example: Excavation

2

Event: it is the state between the completion of a preceding activity and the beginning of the succeeding one. It has no duration an event is shown by a circle or ellipse



1 2

13. Define activity direct cost?

This is the cost that can be traced in full with the execution of a specific activity. It consists of costs of direct labour, direct equipment and other direct costs. For example: in the activity of roof concreting, the following direct costs would be involved.

Types of costs item of costs

Direct materials cost of concrete and steel

Direct labour cost of labour employed

14. Define activity indirect cost?

This is the cost that incurred while performing an activity, but cannot be traced directly to its execution. In other words, all costs other than the direct ones fall in this category. These represent the apportioned share of supervision; general and administration costs are commonly refer to as overheads.

15. **What are the characteristics of a dummy activity?** **(AUC May/June2013)**

A dummy activity is an imaginary activity included in network. Since it is not a real activity, it does not consume time , manpower and material resoures . it is included in a network to maintain the logic and to avoid ambiguity. It is represented by a dotted line and arrow.

16. **What do you understand by job shop scheduling?** **(AUC May/June2012)**

Job planning :

Each job or unit of construction has further planned with respect to the following :

1. **Manner of execution of the jobs** :

The job may be executed departmentally or through contractor .In the case work is done through the contractor type of contractor is to be identified.

2. Duration of the jobs :

(i) Urgency of the work
(ii) Availability of resources
(iii) Position of the construction with reference to ther net work

3. Planning of resources:

Resources of a construction project comprises of the following

(i) Plant, equipment and machinery
(ii) Construction stores
(iii) Construction material
(iv) Both technical and non techanial staff and skilled and unskilled labour.

17. What are the advantages of coding system. . (AUC Apr/May/2010)

The most widely used standard coding system for constructed facilities is the MASTERFORMAT system developed by the Construction Specifications Institute (CSI) of the United States and Construction Specifications of Canada. After development of separate systems, this combined system was originally introduced as the Uniform Construction Index (UCI) in 1972 and was subsequently adopted for use by numerous firms, information providers, professional societies and tradeorganizations.

(PART B- 16MARKS)

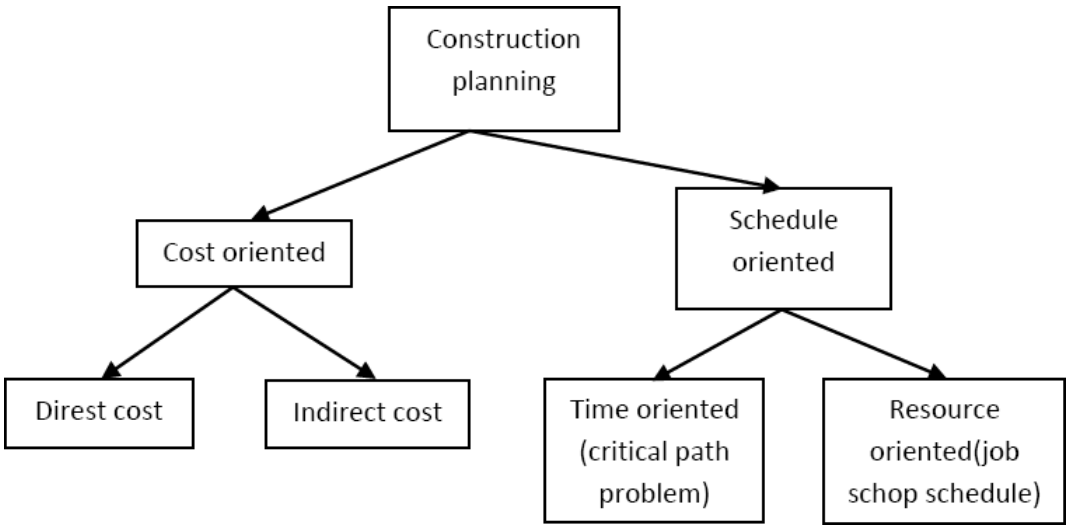
1. What is Construction Planning? Explain the basic concepts in the development of Construction plans.

Construction planning is a fundamental and challenging activity in the management and execution of construction projects. It involves the choice of technology, the definition of work tasks, the estimation of the required resources and durations for individual tasks, and the identification of any interactions among the different work tasks. A good construction plan is the basis for developing the budget and the schedule for work. Developing the construction plan is a critical task in the management of construction, even if the plan is not written or otherwise formally recorded. In addition to these technical aspects of construction planning, it may also be necessary to make organizational decisions about the relationships between project participants and even which organizations to include in a project. For example, the extent to which subcontractors will be used on a project is often determined during construction planning.

A planner begins with a result (i.e. a facility design) and must synthesize the steps required to yield this result. Essential aspects of construction planning include the generation of required activities, analysis of the implications of these activities, and choice among the various alternative means of performing activities. In contrast to a detective discovering a single train of events, however, construction planners also face the normative problem of choosing the best among numerous alternative plans. A planner must imagine the final facility as described in the plans and specifications. In developing a construction plan, it is common to adopt a primary

emphasis on either cost control or on schedule control. Some projects are primarily divided into expense categories with associated costs.

In these cases, construction planning is cost or expense oriented. Within the categories of expenditure, a distinction is made between costs incurred directly in the performance of an activity and indirectly for the accomplishment of the project.
For example, borrowing expenses for project financing and overhead items are commonly treated as indirect costs. For other projects, scheduling of work activities over time is critical and is emphasized in the planning process. In this case, the planner insures that the proper precedence's among activities are maintained and that efficient scheduling of the available resources prevails. Traditional scheduling procedures emphasize the maintenance of task precedence's (resulting in critical path scheduling procedures) or efficient use of resources over time (resulting in job shop scheduling procedures). Finally, most complex projects require consideration of both cost and scheduling over time, so that planning, monitoring and record keeping must consider both dimensions. In these cases, the integration of schedule and budget information is a major concern.



Alternative Emphases in Construction Planning Construction planning is not an activity which is restricted to the period after the award of a contract for construction. It should be an essential activity during the facility design. Also, if problems arise during construction, re-planning is required.

2. Explain briefly Choice of Construction Technology and Construction method? (AUC May/June2013) (AUC Nov/Dec 2011) (AUC May/June2009).

Choice of Construction Technology and Construction method:
As in the development of appropriate alternatives for facility design, choices of appropriate technology and methods for construction are often ill-structured yet critical ingredients in the success of the project. For example, a decision whether to pump or to transport concrete in buckets will directly affect the cost and duration of tasks involved in building construction. A decision between these two alternatives should consider the relative costs, reliabilities, and availability of

equipment for the two transport methods. Unfortunately, the exact implications of different methods depend upon numerous considerations for which information may be sketchy during the planning phase, such as the experience and expertise of workers or the particular underground condition at a site.

In selecting among alternative methods and technologies, it may be necessary to formulate a number of construction plans based on alternative methods or assumptions. Once the full plan is available, then the cost, time and reliability impacts of the alternative approaches can be reviewed. This examination of several alternatives is often made explicit in bidding competitions in which several alternative designs may be proposed or value engineering for alternative construction methods may be permitted. In this case, potential constructors may wish to prepare plans for each alternative design using the suggested construction method as well as to prepare plans for alternative construction methods which would be proposed as part of the value engineering process. In forming a construction plan, a useful approach is to simulate the construction process either in the imagination of the planner or with a formal computer based simulation technique. By observing the result, comparisons among different plans or problems with the existing plan can be identified. For example, a decision to use a particular piece of equipment for an operation immediately leads to the question of whether or not there is sufficient access space for the equipment.

Three dimensional geometric models in a computer aided design (CAD) system may be helpful in simulating space requirements for operations and for identifying any interference.

Similarly, problems in resource availability identified during the Construction planning

- Direst cost
- Indirect cost
- Time oriented
- (critical path problem)
- Resource
- oriented(job schop schedule)
- Schedule
- Cost oriented
- simulation of the construction process might be effectively forestalled by providing additional resources as part of the
- construction plan.

Example- Laser Leveling

An example of technology choice is the use of laser leveling equipment to improve the productivity of excavation and grading. In these systems, laser surveying equipment is erected on a site so that the relative height of mobile equipment is known exactly. This height measurement is accomplished by flashing a rotating laser light on a level plane across the construction site and observing exactly where the light shines on receptors on mobile equipment such as graders. Since laser light does not disperse appreciably, the height at which the laser shines anywhere on the construction site gives an accurate indication of the height of a receptor on a piece of mobile equipment. In turn, the receptor height can be used to measure the height of a blade, excavator bucket or other piece of equipment. Combined with electro-hydraulic control systems mounted on mobile equipment such as bulldozers, graders and scrapers, the height of excavation and grading blades can be precisely and automatically controlled in these systems. This automation of blade heights has reduced costs in some cases by over 80% and improved quality in the finished

product, as measured by the desired amount of excavation or the extent to which a final grade achieves the desired angle. These systems also permit the use of smaller machines and less skilled operators. However, the use of these semi-automated systems requires investments in the laser surveying equipment as well as modification to equipment to permit electronic feedback control units. Still, laser leveling appears to be an excellent technological choice in many instances.

3. Explain coding systems in detail. (AUC May/June2009) (AUC Apr/May2011)

One objective in many const ruction planning efforts is to define the plan within the constraints of a universal coding system for identifying activities. Each activity defined for a project would be identified by a pre-defined code specific to that activity. The use of a common nomenclature or identification system is basically motivated by the desire for better integration of organizational efforts and improved information flow. In particular, coding systems are adopted to provide a numbering system to replace verbal descriptions of items. These codes reduce the length or complexity of the information to be recorded. A common coding system within an organization also aids consistency in definitions and categories between projects and among the various parties involved in a project. Common coding systems also aid in the retrieval of historical records of cost, productivity and duration on particular activities. Finally, electronic data storage and retrieval operations are much more efficient with standard coding systems.

The most widely used standard coding system for constructed facilities is the MASTERFORMAT system developed by the Construction Specifications Institute (CSI) of the United States and Construction Specifications of Canada. After development of separate systems, this combined system was originally introduced as the Uniform Construction Index (UCI) in 1972 and was subsequently adopted for use by numerous firms, information providers, professional societies and tradeorganizations.

The term MASTERFORMAT was introduced with the 1978 revision of the UCI codes. MASTERFORMATprovides a standard identification code for nearly all the elements associated with building construction.MASTERFORMAT involves a hierarchical coding system with multiple levels plus keyword text descriptions of each item.

In the numerical coding system, the first two digits represent one of the sixteen divisions for work; a seventeenth division is used to code conditions of the contract for a constructor. In the latest version of the MASTERFORMAT, a third digit is added to indicate a subdivision within each division. Each division is further specified by a three digit extension indicating another level of subdivisions. In many cases, these subdivisions are further divided with an additional three digits to identify more specific work items or materials.

For example, the code 16-950-960, "Electrical Equipment Testing" are defined as within Division 16 (Electrical) and Sub-Division 950 (Testing). The keywords "Electrical Equipment Testing" is a standard description of the activity.While MASTERFORMAT provides a very useful means of organizing and communicating information, it has some obvious limitations as a complete project coding system. First, more specific information such as location of work or responsible organization might be required for project cost control. Code extensions are then added in addition to the digits in the basic MASTERFORMAT codes. For example, a typical extended code might have the following elements:

0534.02220.21.A.00.cf34

The first four digits indicate the project for this activity; this code refers to an activity on project number 0534. The next five digits refer to the MASTERFORMAT secondary division; referring to Table 9-7, this activity would be 02220 "Excavating, Backfilling and Compacting." The next two digits refer to specific activities defined within this MASTERFORMAT code; the digits 21 in this example might refer to excavation of column footings. The next character refers to the block or general area on the site that the activity will take place; in this case, block A is indicated. The digits 00 could be replaced by a code to indicate the responsible organization for the activity. Finally, the characters cf34 refer to the particular design element number for which this excavation is intended; in this case, column footing number 34 is intended. Thus, this activity is to perform the excavation for column footing number 34 in block A on the site.

4. Discuss the various factors deciding the activity durations. (AUC May/June2009) (AUC Nov/Dec 2010)

In most scheduling procedures, each work activity has associated time duration. These durations are used extensively in preparing a schedule. The entire set of activities would then require at least 3 days, since the activities follow one another directly and require a total of 1.0 + 0.5 + 0.5 + 1.0 = 3 days. If another activity proceeded in parallel with this sequence, the 3 day minimum duration of these four activities is unaffected. More than 3 days would be required for the sequence if there was a delay or a lag between the completion of one activity and the start of another.

Durations and Predecessors for a Four Activity Project Illustration

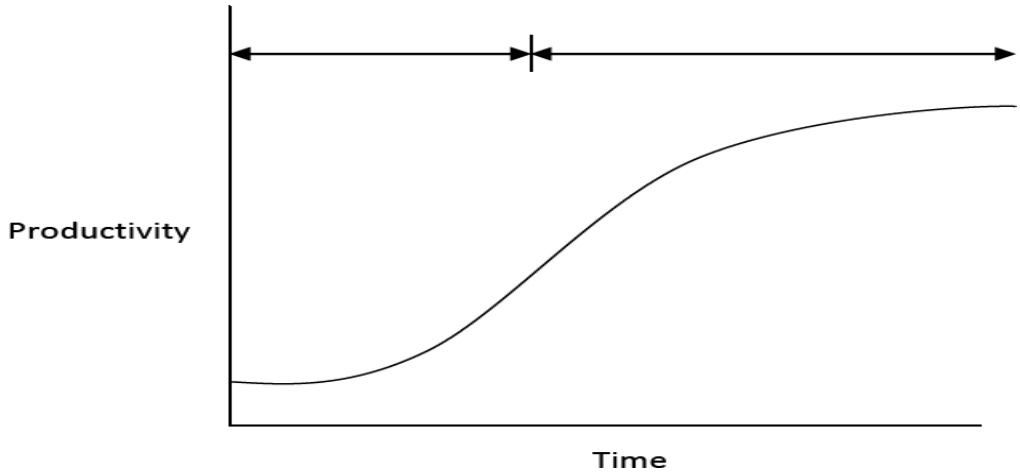
Activity	Predecessor	Duration (Days)
Excavate trench	----	1.0
Place formwork	Excavate trench	0.5
Place reinforcing	Place formwork	0.5
Pour concrete	Place reinforcing	1.0

formal scheduling procedures rely upon estimates of the durations of the various project activities as well as thedefinitions of the predecessor relationships among tasks. The variability of an activity's duration may also be considered.

Formally, the probability distribution of an activity's duration as well as the expected or most likely duration may be used inscheduling. A probability distribution indicates the chance that a particular activity duration will occur. In advance of actuallydoing a particular task, we cannot be certain exactly how long the task will require. A straightforward approach to the estimation of activity durations is to keep historical records of particular activities and rely on the average durations fromthis experience in making new duration estimates. Since the scope of activities are unlikely to be identical between differentprojects, unit productivity rates are typically employed for this purpose. For example, the duration of an activity Dij such as concrete formwork assembly might be estimated as:

$$D_{ij} = \frac{A_{ij}}{P_{ij} N_{ij}}$$

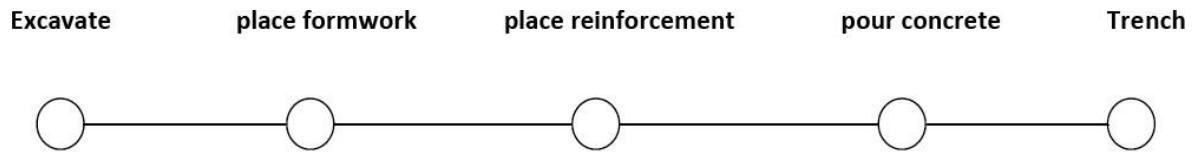
Where Aij is the required formwork area to assemble (in square yards), Pij is the average productivity of a standard
crew in this task (measured in square yards per hour), and Nij is the number of crews assigned to the task. In someorganizations, unit production time, Tij , is defined as the time required to complete a unit of work by a standard crew Learning phase Steady state phase



Random factors will also influence productivity rates and make estimation of activity durations uncertain. For example, a scheduler will typically not know at the time of making the initial schedule how skillful the crew and manager will be that are assigned to a particular project. The productivity of a skilled designer may be many times that of an unskilled engineer. In the absence of specific knowledge, the estimator can only use average values of productivity.

5. Explain how precedence relationship among activities is defined. (AUC Apr/May/2010)

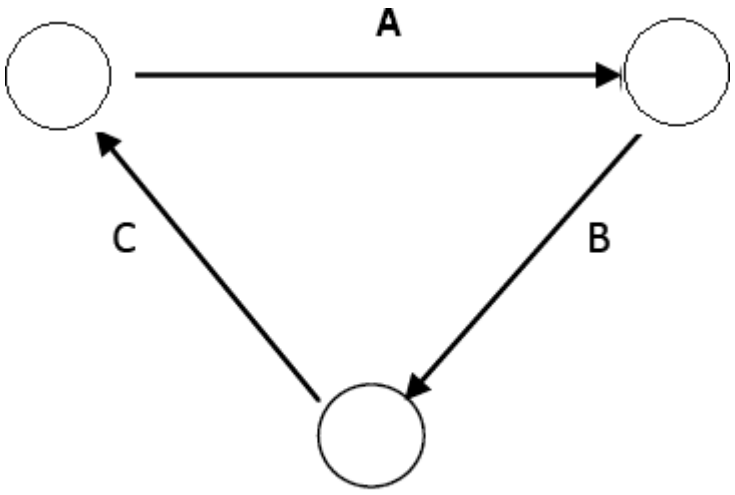
Precedence relations between activities signify that the activities must take place in a particular sequence. Numerous natural sequences exist for construction activities due to requirements for structural integrity, regulations, and other technical requirements. For example, design drawings cannot be checked before they are drawn. Diagramatically, precedence relationships can be illustrated by a network or graph in which the activities are represented by arrows . The arrows in Figure are called branches or links in the activity network, while the circles marking the beginning or end of each arrow are called nodes or events. In this figure, links represent particular activities, while the nodes represent milestone events.



Illustrative Set of Four Activities with Precedences

More complicated precedence relationships can also be specified. For example, one activity might not be able to start for several days after the completion of another activity. As a common example, concrete might have to cure (or set) for several days before formwork is removed. This restriction on the removal of forms activity is called a lag between the completion of one activity (i.e., pouring concrete in this case) and the start of another activity (i.e., removing formwork in this case). Many computer based scheduling programs permit the use of a variety of precedence relationships.Three mistakes should be avoided in specifying predecessor relationships for construction plans.

First, a circle of activity precedences will result in an impossible plan. For example, if activity A precedes activity B, activity B precedes activity C, and activity C precedes activity A, then the project can never be started or completed! Figure 9-4 illustrates the resulting activity network. Fortunately, formal scheduling methods and good computer scheduling programs will find any such errors in the logic of the construction plan.



Example of an Impossible Work Plan

Finally, it is important to realize that different types of precedence relationships can be defined and that each has different implications for the schedule of activities:

- Some activities have a necessary technical or physical relationship that cannot be superseded.
  For example,
  Concrete pours cannot proceed before formwork and reinforcement are in place.
- Some activities have a necessary precedence relationship over a continuous space rather than as discrete work task
  relationships.
  For example, formwork may be placed in the first part of an excavation trench even as the excavation

equipment continues to work further along in the trench. Formwork placement cannot proceed further than the
excavation, but the two activities can be started and stopped independently within this constraint.

- Some "precedence relationships" are not technically necessary but are imposed due to implicit decisions within the
construction plan.

6. Explain the procedure of the estimating the resource requirements for activities. (AUC May/June2012) (AUC Apr/May/2010)

The construction activity process combines resources like

- man power ,
- materials ,
- machinery,
- money ,
- management.

As a matter of fact , the duration of an activity and the resource requirement are linked . For example : considering the placing of a concrete in a large foundation can be arranged manually , using crane and bucket arrangement or pumping concrete by pumps or transporting by conveyor system. The time required and cost for each od these methods will differ considerably. thus it is the method of the production and the time available the dictates the resources like man , material , machine , money , management required for the execution of each activity in a fixed time . the assessment is needed

(i) to forecast resources required
(ii) to develop a time schedule within resource constrains
(iii) to evaluate the connected costs.

The preliminary estimate of resources neede to accomplish an activity can be by using the past experience or the published literature which may be suitably modified to fit in to the project environment.

The resource planning works include the following :

(i) workers output norms
(ii) plant and machinery output norms
(iii) materials quantity estimation and wastage norms .

7. **Explain the stages development of construction planning in detail**.

(AUC May/June2012)

Duration the planning of a construction project ,the entire is phase out identifying the sequence of construction. Secondly each phase is divided for operation in to a number of jobs or units of construction, different stage of planning are ,

1. Job planning
2. Technical planning
3. Contract planning.

Job planning :

Each job or unit of construction has further planned with respect to the following :

4. **Manner of execution of the jobs** :

The job may be executed departmentally or through contractor .In the case work is done through the contractor type of contractor is to be identified.

5. Duration of the jobs :

The factors contribute for the duration of job or the proposed period of the completion are:

(iv) Urgency of the work
(v) Availability of resources
(vi) Position of the construction with reference to ther net work

6. Planning of resources:

Resources of a construction project comprises of the following

(v) Plant, equipment and machinery
(vi) Construction stores
(vii) Construction material
(viii) Both technical and non techanial staff and skilled and unskilled labour

2. **Technical planning:**

Technical planning is done by engineer or concerned authority for economical authority for economical execution of the construction project.

IN starts after the administrative approval of the work is obtained for technical sanction . technical planning is carried out in order mentioned below.

1. Preparation of detailed drawing :

The administrative approval does not contain the working details of various structural members nor does it contain working drawings . these details would be a waste in the event of the project not being approved. However, the details are imminent once the approval is accorded .

2. Preparation of detailed estimate :

A preliminary estimate is made while getting the approval. However , this will not be exhaustive and comprehensive one .therefore after the approval of the work further details in respect of schedule of stores general and particular specifications have to be incorporated with in the frame work .

3. Finalizing method of execution :

The execution may be carried out through contractor or through department.

Execution of the work through contractor has been the most common method of getting the work executed . this is administratively the easiest way of the getting the work done. In case of requirement of heavy machinery or technicality requirement or for so many advantages:

(i) Better quality control
(ii) To suitable in case of the strategic installation and work
(iii) To provide employment to large section

(iv) To prevent accumulation of wealth in the handle of a few companies .

4. Contract planning :

It consists two categories

(i) Pre-tender planning

(ii) Post – tender planning

(i) Pre-tender planning:

Planning required for the time of inviting of tenders up to the receipt of the same is termed as pre-tender planning .

it consists of the following works:

(i) Finalization and acquisition of site :

Before issues of the order to contractors the acquisition of the project site has to be finalized and legal issues if any should be finalized.

(ii) Planning resources :

1. Availability of site
2. Availability of stores
3. Availability of labours .
4. Availability of equipment and plants

(iii) Planning time limit :

The requirement of resources and time limit are inter – related and both these aspects are to be taken together.

In some cases the time needed for completion is decided based on the Availability resources such is the case when the work has to be completed departmentally . Even when the work has to be executed by the contractor the duration of the project has to be decided and notified before investing tenders . as a matter of fact tha contractor submits tender considering the following aspects :

1. Site survey
2. Availability of material
3. Equipment and plants to be hired and purchased
4. Fuel
5. Labour
6. Facilities for camp
7. Study of drawing / design / specifications.

2. **Post – tender planning:**

Its done by contractor or departmentally

1. Setting camp site office
2. Welfare of staff /labour amenties
3. Materials required
4. Equipment
5. Safety measures to avoid accidents and theft
6. Follow up of drawing / specifications

7. Billing and to calculate materials and labour and to record progress .

8. Explain the advantages and limitations of planning.

The advantages of planning:

1. Decision of a network or a bar makes the contractor to know more about the job
2. A properly drawn up programmed with cost control can prevent the money and the help to reduce the finished burder of the contractors
3. By properly drawn up program me , the required labour week by week can be easily supplied .
4. The program provides a standard against which actual work can be measured.
5. Due to client to know exactly how long it will take to construct the building and what length of time his captain will be unproductive while tied up in construction work.
6. Due to engineers to the program of the work is normally prepared in consulation with the engineer and the contractor . hence everyone known the scope of the work
7. The target has been laid down for various operations and is available to hin for consultation.

The limitations:

(i) Effective's of the plan depends upon the corrections of assumptions.
(ii) Panning is expensive
(iii) Planning delays action
(iv) Planning encourages of false sense of activity.

9. Explain the estimation of the activity durations in detail. (AUC May/June2013) (AUC Nov/Dec 2011) (AUC May/June2012) (AUC Apr/May/2010)

Duration of activity is defined as the experience economical transaction time required to perform an activity according to the specified execution method.

(i) **Duration is transaction time :**

The transaction of an activity is the time taken to change from one state to the next within the system . in the other words the time delay occurred in moving from one event to its succeeding event . if the details of activity is smaller , then better the assessment of a project the activity duration . however , in long run during the progress of a project the up and down variations in a activity in activity duration get adjusted .

(ii) **Duration is assessed based on the specified execution method :**

(i) The past experience
(ii) The market availability of appropriate resources
(iii) The resources available
(iv) The cost – benefits analysis of the various method of the execution

(iii) **Duration is assessed based on resources earmarked:**

Duration of an activity also depends on the volume and the nature of resources earmarked for execution. The resources are men, machine, material, management ,required for the execution of each activity .

(iv) **Duration is economical transaction time :**

The assessment of expected time should be based on the most economical method working condition by the available or earmarked resources.

(v) **Duration is estimated in term of predetermined units of time :**

(i) Project summary schedule months or weeks
(ii) Project master schedule weeks
(iii) Detailed work program working days or hours

2. **Duration estimate methods :**

1. One-time estimate
2. Three – time estimate
3. Non-liner distribution estimate

1. One-time estimate:

Its based on the following methods :

(i) Planning data
(ii) Past experience on execution of a similar project.
(iii) Average time assessed by a group of executive.

Based on the departmental panning data, or the past experience on a similar work or average value assessed by a group of experts in the construction gives the duration time of the work . the method of one – time estimate is simple and can easily by the followed by all concerned with the panning of execution of the construction work .

2. **Three times PERT estimate:**

When it is difficult to assess the time easily and is not certain the three time estimate is used to compute the expected duration of an activity . to be calculate the expected duration of such an activity ,

$$T_e = (T_O + 4T_M + T_P)/6$$

T_e= expected completion time
T_O = optimistic time
T_P = pessimistic
T_M= most likely time .

Three times estimate can effectively be used in areas of the construction projects where the time is the prime concern than resources employed. Some of these are as the follows:

(i) Panning of the project especially at the feasibility stage.
(ii) Skeleton networks enclosed with time are the main consideration for the management.
(iii) Complex structures, where the exact duration estimate is difficult to access.

7. Non – liner distribution estimate:

Duration estimation based one – time method assume an average daily uniform manpower or effort of work throughout the execution of activity . this may be not be practicable , as some activities may demand more effort and in such non-liner distributions may follow any pattern such as triangular , trapezoidal , beta . some of the approximate non-linear probability distributions into expected or mean value .

4. **Procedure to estimate duration :**
   - **(i)** Method of execution ic decided
   - **(ii)** Quantity of work involved is estimated
   - **(iii)** Requirement of resources are identified
   - **(iv)** Effective employment of resources are assessed
   - **(v)** Activity completion period using estimated resources is estimated .

     Completion period = quantity/ (output per unit of resources x resources earmarked)
   - **(vi)** Completion period is rounded off to the nearest value after making reasonable

     Contingency.
   - **(vii)** Three time estimate or non – liner estimate is used where it is not possible to predict responsible activity duration by one time method and then convert it onr tome estimate.

QUESTION WITH ANSWERS

DEPARTMENT : CIVIL **SEMESTER: V**

SUB.CODE/ NAME: CE 2353 / CONSTRUCTION PLANNING AND SCHEDULING

UNIT- 2 SCHEDULING PROCEDURES AND TECHNIQUES

(PART A- 2MARKS)

1. What is the object of scheduling?.

Scheduling means putting the plan on calendar basis. A project network shows the sequence and inters dependencies of activities, their time and their earliest and latest completion time, but these needs to be scheduled to determine commencement and termination dates of each activity. Using optimum resources or working within resource constraints, it is a time table of work. A basic distinction exists between resource oriented scheduling techniques. The project is divided into number of operations.

2. List out the advantages of scheduling.

1. By studying of any work and the many alternative methods of execution, we can choose the best one.
2. It gives a clear idea regarding the required men, materials and equipments at different stages of work.
3. Resource utilization is optimized.
4. Actual progress of the work is monitored with the actual plan. If there is any delay, proper remedial measures can be taken to avoid such delays.

3. What is the purpose of work scheduling?

The bar – chart type work schedule provides a simplified version of the work plan, which can easily be understood by all concerned with planning, co – ordination, execution and control of the project.

(b) It validates the time objectives:

A work schedule shows the planned sequence of activities, data – wise while putting the work plan on a calendar basis, it takes into account reduced efficiency of resources to adverse climatic conditions and other factors.

(c) It evaluates the implications of scheduling constraints:

A work schedule brings out the implications of constraints and enables preparation of a plan of work within the frame work of these constraints.

4. What are the steps involved in schedule chart?

(a) Select the EST point of activity layout on the graph, and draw a line sloping equal to its rate of execution i.e., 1 unit per day.

(b) Plot the lowest rate slowing line and mark its intersection with the top to foundation horizontal line.

(c) Starting from the point of intersection, move forward horizontally on the top line and identify latest completion point of subsequent activity as indicated by the set back.

5. What are the factors affecting work scheduling? **(AUC Nov/Dec 2010)**

(a) Time:

Most of the projects carry time constraints in the form of imposed dates, these dates may include constraints on start and completion of activities.

(b) Manpower:
Man power is one of the main in the successful execution of projects. The idle labour time is paid for and the strikes and breakdown of work are kept in view by manpower.
(c) Materials:
Construction materials are increasingly becoming scarce and their procurement is a time consuming process. The schedule aids in forecasting of materials and their timely supply determines the economics and progress work.
6. What is the purpose of numbering events?
i. It simplifies the identification and description of a n activity in terms of event numbers.
ii. The activities are coded as i- j where i and j are the event numbers as commencement and termination of an activity.
iii. It helps in developing identification code for computer application.
iv. It systematizes the computations of critical path for each activity as far as possible, the number of the proceeding event it should be less than that of the succeeding event.
7. Define the following terms: (AUC Apr/May 2011) . (AUC May/ June 2009)

1. Critical path:
The longest path through the network is called critical path and its length determines the minimum durations in which the project can be completed.
2. PERT (Program Evaluation and Review Technique):
PERT is vent oriented. It is parabolistic model i.e., it takes into account uncertainties involved in the estimation time of a job or an activity. It uses three estimates of the activity time, optimistic time and pessimistic time and, most likely time.
3. Dummy activity:
It is superimposed activity, which does not represent any specific operation or process. It has zero duration and consumes no resources, its purpose is twofold.
(a) To provide a logical link to maintain the correct.
(b) To simplify the description of concurrent activities in terms of event numbers. The dummy activity is drawn like any other activity, but with dotted lines.
8. What is the significance of critical path?
(a) It is the longest path in the network; however it is possible for a network to have more than one critical path. The sum of the durations of critical activities along the critical path determines the duration of the project.
(b). It is the most sensitive path, any change in duration critical activities along the critical path is bound to effect the duration of the entire project.
9. Define the following terms. (AUC May/ June 2009)
1. EST (Earliest Start Time):
This is the earliest time an activity can be started, assuming that all the activities prior to it have taken place as early as possible.
2. LST (Latest Start Time) :
This is the latest time an activity can start consistent, with the completion of the project in the stipulated time. The LST of an activity is determined by subtracting the activity duration from the LFT of succeeding event.
3. EFT (Earliest Finish Time):
It is the earliest time by which an activity can be completed assuming that all the activities prior to it begin at their EST.
4. LFT (Latest Finish Time):
It is the latest time by which an activity must be completed to ensure the completion of project within the stipulated time.
10. What are the classifications of networks?
1. Skeleton network
2. Master network
3. Detail network

4. Summary network.

11. Define the following terms: **(AUC Nov / Dec 2011)**

(a) Float:

The difference between the latest start time and earliest start time of an activity is called as float. Float is a measure of the amount of time by which the start of an activity can be delayed consistent with the completion of the project on time.

(b) Total Float:

Total float of an activity is defined as the difference between the maximum duration of time available for the completion and duration required to carry out that duration.

12. What is mean by resource leveling and crashing?

Resource leveling:

The aim is reduce the peak resource requirements and smooth out period to period assignment within a constraint on the project duration.

Crashing:

Higher amounts of direct activity cost would be associated with smaller activity duration times, while longer duration time would involve comparatively lower direct cost. Such deliberate reduction of activity times by putting in extra effort is called Crashing.

13. Define the following terms:

1. Normal cost:

Normal cost is the lowest possible direct cost required to complete an activity.

2. Normal time:

Normal time is the maximum time required to complete an activity at normal cost.

3. Crash time:

Crash time is the minimum possible time in which an activity can be completed using additional resources.

4. Crash cost:

Crash cost is the direct cost i.e., anticipated in completing an activity within the crash time.

14. Define activity cost slope.

Activity cost slope is the rate of increase in the cost of activity per unit with a decrease in time. The cost slope indicates the additional cost incurred per unit of time saved in reducing the duration of an activity.

Activity Cost slope = crash cost – Normal cost / Normal time – Crash time.

15. Define activity cost slope.

Activity cost slope is the rate of increase in the cost of activity per unit with a decrease in time. The cost slope indicates the additional cost incurred per unit of time saved in reducing the duration of an activity.

$$\text{Activity Cost slope} = \frac{\text{crash cost} - \text{Normal cost}}{\text{Normal time} - \text{Crash time}}$$

16. What is called time limited schedule? **(AUC May/June 2013)**

Most of the projects have time constraints or dead lines. These dates include constraints on start on start and completion activities . Evidently a schedule must the project time constraints . this is essential as the project duration is not exceeded such a schedule is called time –limited schedule .

17. What is resource –limited schedule? (AUC May/June 2013)

Scheduling must make of reserve of time available in floats. For minor function, working overtime may also be resorted to . the schedule prepared under resource constraints is termed as resource – limited schedule .

18. Define time cost trade –off. (AUC May/June 2013)

A project – in – change or the project manager deals with two important resources, time, and cost . Both then resources have their own constraints. Job of a project manager is to have a judicious balance between time and cost is called the time cost trade off.

19. Define resource constraints. (AUC May/June 2012)

At the other extreme, projects with numerous important resource constraints might be best scheduled by considering critical resources first. A mixed approach would be to proceed simultaneously considering precedence and resource constraints.
A simple modification to critical path scheduling has been shown to be effective for a number of scheduling problems and is
simple to implement.

20. Define scheduling problem? (AUC Apr/May 2011)

Two problems arise in developing a resource constrained project schedule. First, it is not necessarily the case that a critical path schedule is feasible. Because one or more resources might be needed by numerous activities, it can easily be the case
that the shortest project duration identified by the critical path scheduling calculation is impossible. The difficulty arises because critical path scheduling assumes that no resource availability problems or bottlenecks will arise. Finding a feasible or possible schedule is the first problem in resource constrained scheduling

21. Differentiate activity and node. (AUC May/ June 2009) (AUC Nov / Dec 2011)

An activity is any identifiable job that has a beginning and an end. An activity consumes time , manpower and material resources.

An event also called as a node , is the beginning or end of an activity . hence A is the activity (1) and (2) are nodes .

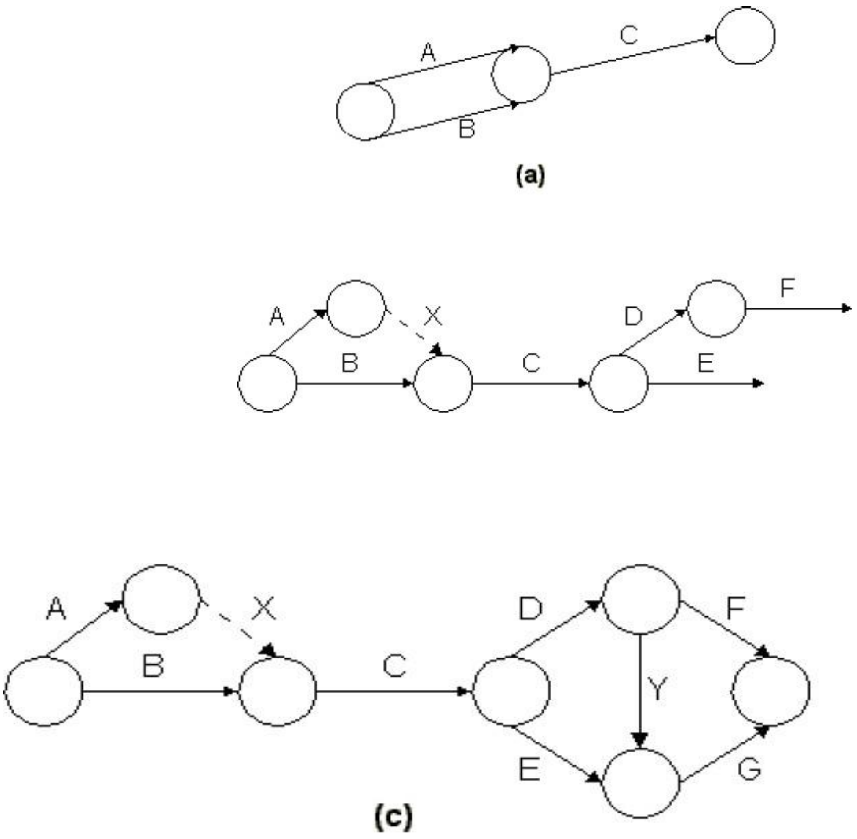
PART-B (16MARKS)

1. Explain Critical path method with neat sketches.

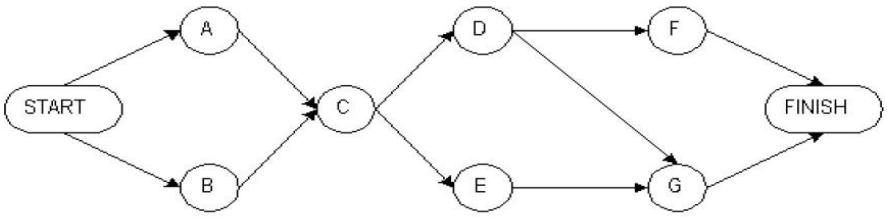
The most widely used scheduling technique is the critical path method (CPM) for scheduling, often referred to as critical path scheduling. This method calculates the minimum completion time for a project along with the possible start and finish
times for the project activities. Indeed, many texts and managers regard critical path scheduling as the only usable and practical scheduling procedure. Computer programs and algorithms for critical path scheduling are widely available and can efficiently handle projects with thousands of activities. The critical path itself represents the set or sequence of predecessor/successor activities which will take the longest time to
complete. The duration of the critical path is the sum of the activities' durations along the path. Thus, the critical path can be defined as the longest possible path through the "network" of project activities. The duration of the critical path represents

the minimum time required to complete a project. Any delays along the critical path would imply that additional time would be required to complete the project.
There may be more than one critical path among all the project activities, so completion of the entire project could be delayed by delaying activities along any one of the critical paths.

For example, a project consisting of two activities performed in parallel that each require three days would have each activity critical for a completion in three days.
Formally, critical path scheduling assumes that a project has been divided into activities of fixed duration and well defined predecessor relationships. A predecessor relationship implies that one activity must come before another in the schedule.
No resource constraints other than those implied by precedence relationships are recognized in the simplest form of critical path scheduling.



An Activity-on-Branch Network for Critical Path Scheduling



An Activity-on-Node Network for Critical Path Scheduling

2. Explain Activity float and schedules.

A number of different activity schedules can be developed from the critical path scheduling procedure described in the previous section. An earliest time schedule would be developed by starting each activity as soon as possible, at ES(i,j).

Similarly, a latest time schedule would delay the start of each activity as long as possible but still finish the project in the minimum possible time. This late schedule can be developed by setting each activity's start time to LS(i,j).

Activities that have different early and late start times (i.e., ES(i,j) < LS(i,j)) can be scheduled to start anytime between ES(i,j)

and LS(i,j). The concept of float is to use part or all of this allowable range to schedule an activity without delaying the completion of the project. An activity that has the earliest time for its predecessor and successor nodes differing by more than its duration possesses a window in which it can be scheduled. That is, if E(i) + Dij < L(j), then some float is available in which to schedule this activity.

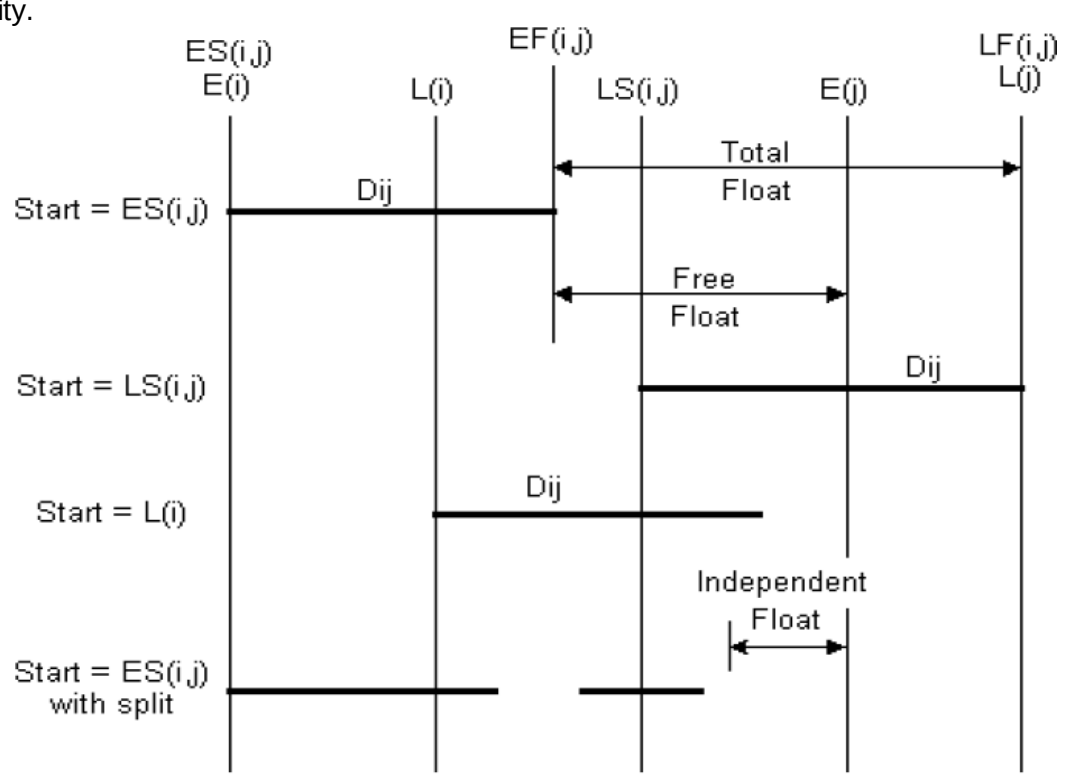
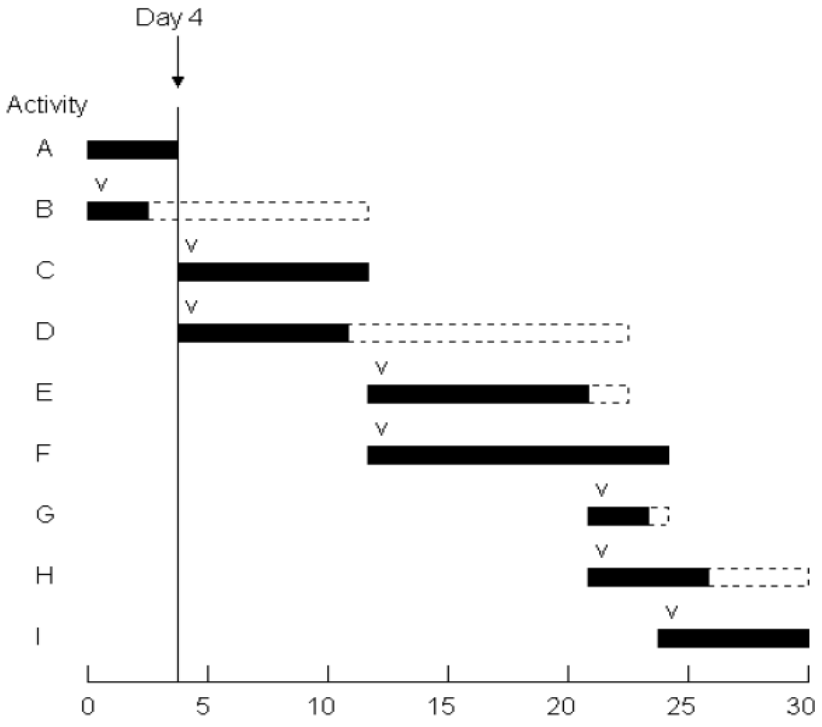


Illustration of Activity Float

Float is a very valuable concept since it represents the scheduling flexibility or "maneuvering room" available to complete particular tasks. Activities on the critical path do not provide any flexibility for scheduling nor leeway in case of problems. For
activities with some float, the actual starting time might be chosen to balance workloads over time, to correspond with material deliveries, or to improve the project's cash flow.

3. Describe various methods of presenting project schedules.

Communicating the project schedule is a vital ingredient in successful project management. A good presentation will greatly ease the manager's problem of understanding the multitude of activities and their inter-relationships. Moreover, numerous
individuals and parties are involved in any project, and they have to understand their assignments. Graphical presentations of project schedules are particularly useful since it is much easier to comprehend a graphical display of numerous pieces of information than to sift through a large table of numbers. Early computer scheduling systems were particularly poor in this regard since they produced pages and pages of numbers without aids to the manager for understanding them. It is extremely tedious to read a table of activity numbers, durations, schedule times, and floats and thereby gain an understanding and appreciation of a project schedule. In practice, producing diagrams manually has been a common
prescription to the lack of automated drafting facilities. Indeed, it has been common to use computer programs to perform critical path scheduling and then to produce bar charts of detailed activity schedules and resource assignments manually. With the availability of computer graphics, the cost and effort of producing graphical presentations has been significantlyreduced and the production of presentation aids can be automated. Network diagrams for projects have already been introduced. These diagrams provide a powerful visualization of the precedences and relationships among the various project activities. They are a basic means of communicating a project plan among the participating planners and project monitors. Project planning is often conducted by producing network representations of greater and greater refinement until the plan is satisfactory.



satisfactory.

An Example Bar Chart for a Nine Activity Project

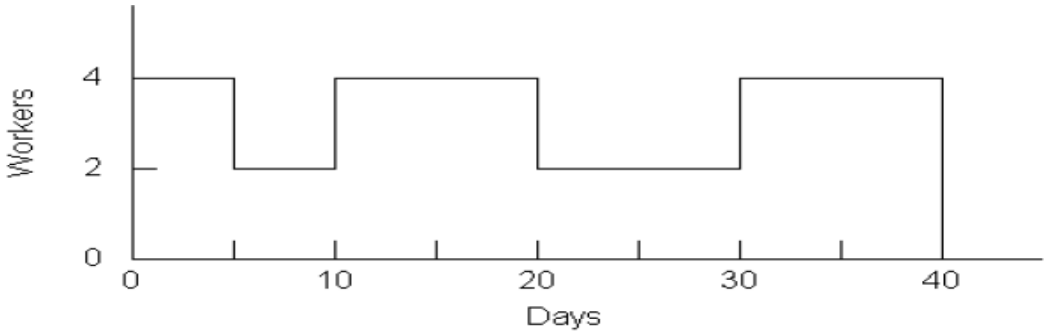
Bar charts are particularly helpful for communicating the current state and schedule of activities on a project. As such, they have found wide acceptance as a project representation tool in the field. For planning purposes, bar charts are not as useful
since they do not indicate the precedence relationships among activities. Thus, a planner must remember or record separately that a change in one activity's schedule may require changes to successor activities. There have been various schemes for mechanically linking activity bars to represent precedences, but it is now easier to use computer based tools to
represent such relationships.

5. Explain Scheduling with Resource Constraints and Precedence

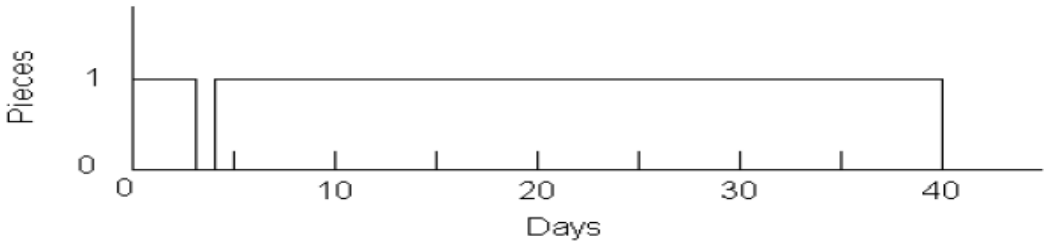
Two problems arise in developing a resource constrained project schedule. First, it is not necessarily the case that a critical path schedule is feasible. Because one or more resources might be needed by numerous activities, it can easily be the case
that the shortest project duration identified by the critical path scheduling calculation is impossible. The difficulty arises because critical path scheduling assumes that no resource availability problems or bottlenecks will arise. Finding a feasible or possible schedule is the first problem in resource constrained scheduling. Of course, there may be a numerous possible schedules which conform with time and resource constraints. As a second problem, it is also desirable to determine schedules which have low costs or, ideally, the lowest cost. Numerous heuristic methods have been suggested for resource constrained scheduling. Many begin from critical path schedules which are modified in light of the resource constraints. Others begin in the opposite fashion by introducing resource constraints and then imposing precedence constraints on the activities. Still others begin with a ranking or classification of activities into priority groups for special attention in scheduling.One type of heuristic may be better than another for different types of problems. Certainly, projects in which only an occasional resource constraint exists might be
best scheduled starting from a critical path schedule. At the other extreme, projects with numerous important resource constraints might be best scheduled by considering critical resources first. A mixed approach would be to proceed simultaneously considering precedence and resource constraints.

A simple modification to critical path scheduling has been shown to be effective for a number of scheduling problems and issimple to implement. For this heuristic procedure, critical path scheduling is applied initially. The result is the familiar set of possible early and late start times for each activity. Scheduling each activity to begin at its earliest possible start time may result in more than one activity requiring a particular resource at the same time. Hence, the initial schedule may not be feasible. The heuristic proceeds by identifying cases in which activities compete for a resource and selecting one activity to proceed. The start time of other activities are then shifted later in time. A simple rule for choosing which activity has priority is to select the activity with the earliest CPM late start time (calculated as LS(i,j) = L(j)-Dij) among those activities which are both feasible (in that all their precedence requirements are satisfied) and competing for the resource. This decision rule is applied from the start of the project until the end for each type of resource in

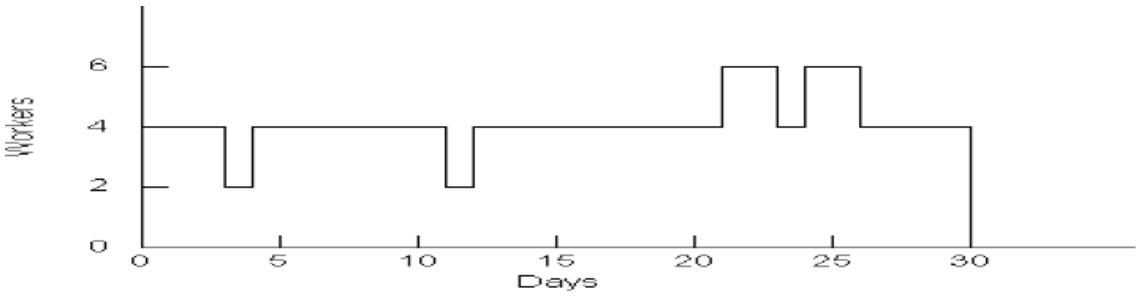
turn.



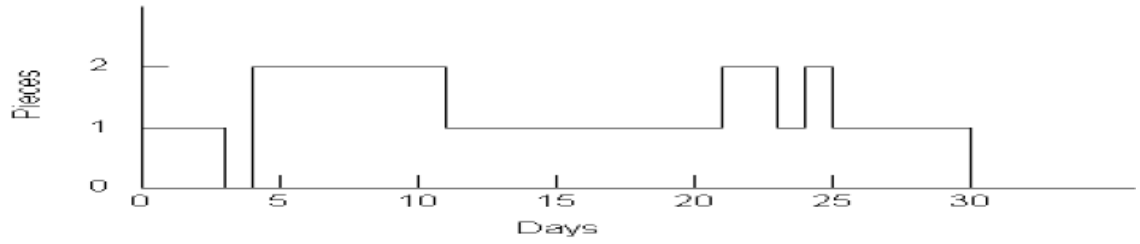
(a) Workers Required



(b) Equipment Required



(a) Workers Required



(b) Equipment Required

6. Explain the differnce between CPM and PERT in detail

The difference between CPM and PERT have been talked over the years . the original difference and later development are discussed below .

S.No	FACTORS	CPM	PERT
1	Field of application	Deterministic projects like in construction	Projects involving uncertainties like research and development .
2	Model emphasis	Activity oriented	Events oriented
3	Activity duration estimation	One time method	Three times method
4	Time cost trade off	Feasible	Not Feasible
5	Resources optimization	Feasible	Not Feasible
6	Techniques complexity	Simple	Comparatively difficult

The difference are the further summerset below :

1. For the planning and control of civil works CPM was developed whereas PERT originated to meet the uncertainties in research and development projects .
2. A CPM network is built on the basis of jobs or activities whereas PERT concentrated;' on events
3. Originally CPM was dealt for works where the activities were familiar and then could be estimated easily from one time estimate . but PERT was designed to cope with uncertainties , thus adopted three time estimates .
4. A CPM activity durations were related which provided means of assessment of different activity durations with varying costs and made crashing activity possible . PERT dealt with events and their probable time of occurrence which enabled adoption of probabilistic approach in time scheduling.
5. In CPM schedule resource optimization in feasible which is not possible in PERT .
6. CPM was simpler as it is based on one time estimate whereas PERT requires a statically approach .

7. For the given data below of a construction project schedule determine the critical path and all floats.

Activity	A	B	C	D	E	F	G
Predecessors	–	–	A,B	C	C	D	D,E
Durations	3	5	4	6	3	2	4

(Anna Univ., May/June 2013)

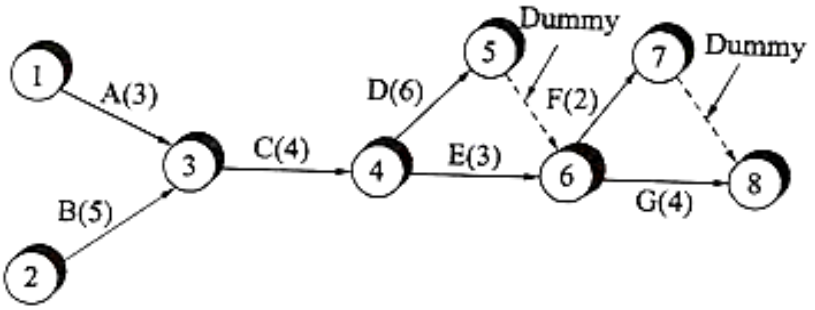


Fig. 4.27

Solution

	Path	Duration
(i)	$1 \rightarrow 3 \rightarrow 4 \rightarrow 5 \rightarrow 6 \rightarrow 7 \rightarrow 8$	$3 + 4 + 6 + 0 + 2 + 0 = 15$
(ii)	$1 \rightarrow 3 \rightarrow 4 \rightarrow 5 \rightarrow 6 \rightarrow 8$	$3 + 4 + 6 + 0 + 4 = 17$
(iii)	$1 \rightarrow 3 \rightarrow 4 \rightarrow 6 \rightarrow 8$	$3 + 4 + 3 + 4 = 14$
(iv)	$1 \rightarrow 3 \rightarrow 4 \rightarrow 6 \rightarrow 7 \rightarrow 8$	$3 + 4 + 3 + 2 + 0 = 12$
(v)	$2 \rightarrow 3 \rightarrow 4 \rightarrow 5 \rightarrow 6 \rightarrow 7 \rightarrow 8$	$5 + 4 + 6 + 0 + 2 + 0 = 17$
(vi)	$2 \rightarrow 3 \rightarrow 4 \rightarrow 5 \rightarrow 6 \rightarrow 8$	$5 + 4 + 6 + 0 + 4 = 19$
(viii)	$2 \rightarrow 3 \rightarrow 4 \rightarrow 6 \rightarrow 8$	$5 + 4 + 3 + 4 = 16$
(ix)	$2 \rightarrow 3 \rightarrow 4 \rightarrow 6 \rightarrow 7 \rightarrow 8$	$5 + 4 + 3 + 2 + 0 = 14$

The longest path in a network is called critical path. In this network, the maximum duration of path comparing to others is 19 unit, is $2 \rightarrow 3 \rightarrow 4 \rightarrow 5 \rightarrow 6 \rightarrow 8$

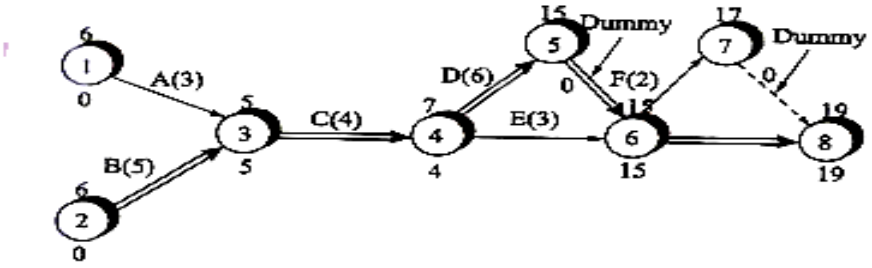


Fig. 4.28

Fig.

Activity	Duration	Start time		Finish time		Float time		
		EST	LST	EFT	LFT	Total	Free	Independent
1-3	3	0	2	3	5	2	2	2
2-3	5	0	0	5	5	0	0	0
3-4	4	5	5	9	9	0	0	0
4-5	6	9	9	15	15	0	0	0
4-6	3	9	12	12	15	3	3	3
5-6	—	15	15	15	15	0	0	0
6-7	2	15	17	17	19	2	0	0
6-8	4	15	15	19	19	0	0	0
7-8	—	17	19	17	19	2	2	0

Example for Activity 1-3

Total float

= LFT of lead event (2) – EST of tail event (1) – Duration

= [(5 – 0) – 3] = 2

Free float

= Total float – Slack time of head event (2)

= Total float – (LFT – EST) of event (2)

= 2 – (5 – 5) = 2

Independent float

= Free float – Slack time of tail event (1)

= 2 – (0 – 0) = 2

8. Find the data given below of a construction project schedule, determine the critical path.

Activity	A	B	C	D	E	F	G
Predecessors	–	–	A,B	C	C	D	D,F
Durations	3	5	4	6	3	5	6

Solution

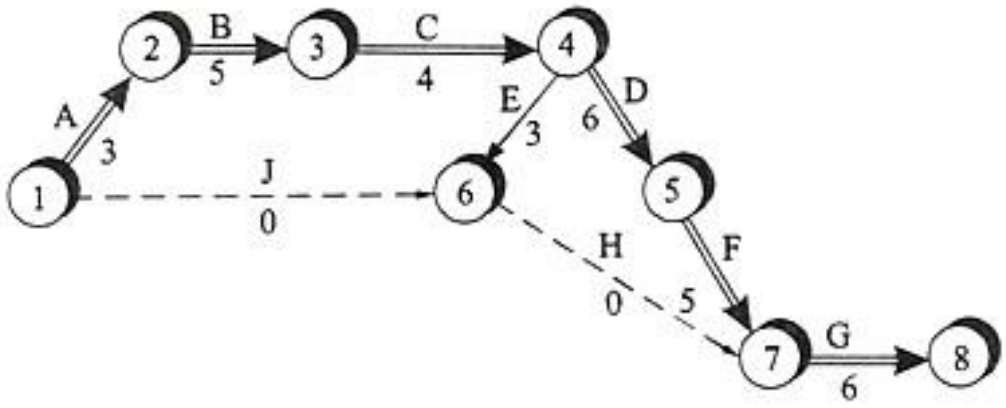


Fig. 4.22

$A \rightarrow B \rightarrow C \rightarrow D \rightarrow F \rightarrow G = 3 + 5 + 4 + 6 + 5 + 6 = 29$ units

$A \rightarrow B \rightarrow C \rightarrow E \rightarrow H \rightarrow G = 3 + 5 + 4 + 3 + 0 + 6 = 21$ units

The critical path is $A \rightarrow B \rightarrow C \rightarrow D \rightarrow F \rightarrow G$ and the duration is 29 units.

The critical path is shown by double line in Fig. 4.22.

9. **The details of a network are given below where the durations are in days. Find the critical path and project completion time.**

Activity	:	A	B	C	D	E	F	G	H	I
Predecessor	:	–	–	A	A	B	B	D	D	F
Duration	:	4	3	8	7	9	12	2	5	6

(Anna Univ., April/May 2012)

Solution

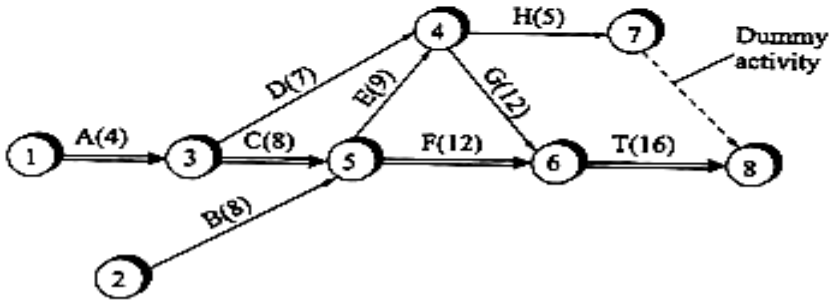


Fig. 4.29 Network diagram

To find critical path:

	Path	Duration	Days
(i)	$1 \rightarrow 3 \rightarrow 4 \rightarrow 7 \rightarrow 8$	$4 + 7 + 5 + 0$	$= 16$
(ii)	$1 \rightarrow 3 \rightarrow 4 \rightarrow 6 \rightarrow 8$	$4 + 7 + 2 + 6$	$= 19$
(iii)	$1 \rightarrow 3 \rightarrow 5 \rightarrow 4 \rightarrow 6 \rightarrow 8$	$4 + 8 + 9 + 2 + 6$	$= 29$
(iv)	$1 \rightarrow 3 \rightarrow 5 \rightarrow 6 \rightarrow 8$	$4 + 8 + 12 + 6$	$= 30$
(v)	$2 \rightarrow 5 \rightarrow 4 \rightarrow 7 \rightarrow 8$	$3 + 9 + 5 + 0$	$= 17$
(vi)	$2 \rightarrow 5 \rightarrow 4 \rightarrow 6 \rightarrow 8$	$3 + 9 + 2 + 6$	$= 20$
(vii)	$2 \rightarrow 5 \rightarrow 6 \rightarrow 8$	$3 + 12 + 6$	$= 21$
(viii)	$1 \rightarrow 3 \rightarrow 5 \rightarrow 4 \rightarrow 7 \rightarrow 8$	$4 + 8 + 9 + 5 + 0$	$= 26$

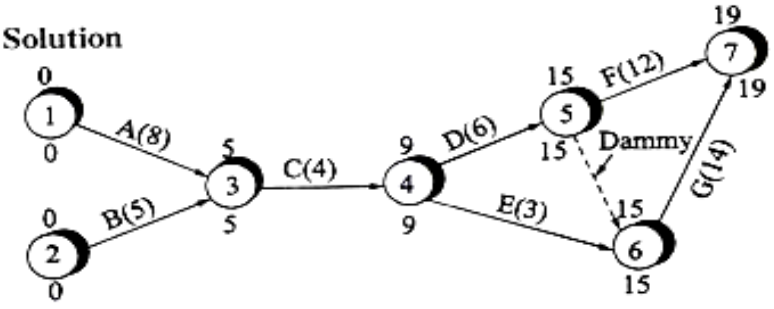
The maximum duration is 30 days. So, the critical path is $1 \rightarrow 3 \rightarrow 5 \rightarrow 6 \rightarrow 8$

Project completion time = 30 days

10. The details of a network are given below where duration are in days. Find the critical path. Project completion time and all floats

Activity	:	A	B	C	D	E	F	G
Predecessor	:	–	–	A,B	C	C	D	D,E
Duration	:	3	5	4	6	3	2	4

Solution



To find critical path:

	Path	Duration	Days
(i)	$1 \rightarrow 3 \rightarrow 4 \rightarrow 5 \rightarrow 7$	$3 + 4 + 6 + 2$	$= 15$
(ii)	$1 \rightarrow 3 \rightarrow 4 \rightarrow 5 \rightarrow 6 \rightarrow 7$	$3 + 4 + 6 + 0 + 4$	$= 17$
(iii)	$1 \rightarrow 3 \rightarrow 4 \rightarrow 6 \rightarrow 7$	$3 + 4 + 3 + 4$	$= 14$
(iv)	$2 \rightarrow 3 \rightarrow 4 \rightarrow 5 \rightarrow 7$	$5 + 4 + 6 + 2$	$= 17$
(v)	$2 \rightarrow 3 \rightarrow 4 \rightarrow 5 \rightarrow 6 \rightarrow 7$	$5 + 4 + 6 + 0 + 4$	$= 19$
(vi)	$2 \rightarrow 3 \rightarrow 4 \rightarrow 6 \rightarrow 7$	$5 + 4 + 3 + 4$	$= 16$

The maximum duration is 19 days. So, the critical path is $2 \rightarrow 3 \rightarrow 4 \rightarrow 5 \rightarrow 6 \rightarrow 7$.

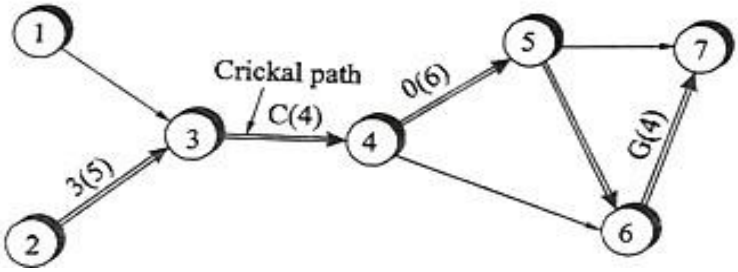


Fig. 4.31

Activity	Duration	Start time		Finish time		Float time		
		EST	LST	EFT	LFT	Total	Free	Independent
1-3	3	0	2	3	5	2	2	2
2-3	5	0	0	5	5	0	0	0
3-4	4	5	5	9	9	0	0	0
4-5	6	9	9	15	15	0	0	0
4-6	3	9	12	12	15	3	3	3
5-6	0	15	15	15	15	0	0	0
5-7	2	15	17	17	19	2	2	0
6-7	4	15	15	19	19	0	0	0

Example for Activity 1-3

Total float

= LFT of lead event (2) – EST of tail event (1) – Duration

= [(5 – 0) – 3] = 2

Free float

= Total float – (LFT – EST) of event (2)

= 2 – (5 – 5) = 2

Independent float

= Free float – Slack time of tail event (1)

= 2 – (0 – 0) = 2

11. Construct the network diagram and find the earliest and latest times.

Activity	Predecessors	Duration
A	–	6
B	A	7
C	A	1
D	–	14
E	B	5
F	C, D	8
G	C, D	9
H	D	3
I	H	5
J	F	3
K	E, J	4
L	F	12
M	G, I	6
N	G, I	2
O	L, N	7

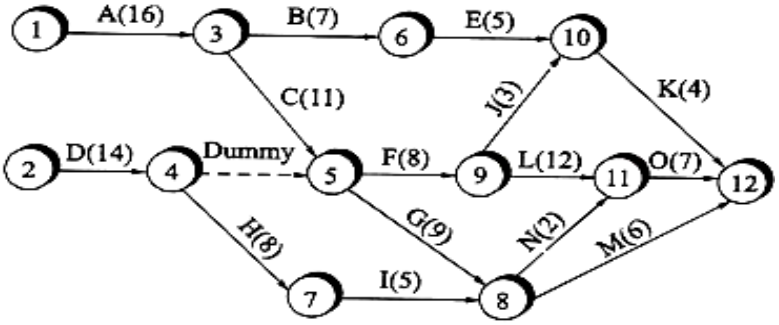


Fig. 4.32

Solution

EST

EST (1) = 0

EST (2) = 0

EST (3) = 0 + 6 = 6

EST (4) = 0 + 14 = 14

EST (5) = EST (3) + 1

= 6 + 1 = 7

EST (5) = EST (4) + 0 = 14 + 0 = 14

So maximum EST (5) = 14

LFT (9) = LFT (11) – 12 = 34 – 12 = 22

LFT (9) = LFT (10) – 3 = 37 – 3 = 34

So min. value, take LFT (9) = 22

LFT (8) = LFT (12) – 6 = 41 – 6 = 35

LFT (8) = LFT (11) – 2 = 34 – 2 = 32

So take LFT (8) = 32

LFT (7) = LFT (8) – 5 = 32 – 5 = 27

LFT (6) = LFT (10) – 5 = 37 – 5 = 32

LFT (5) = LFT (9) – 8 = 22 – 8 = 14

LFT (5) = LFT (8) – 9 = 32 – 9 = 23 So take LFT (5) = 14

LFT (4) = LFT (5) – 0 = 14 – 0 = 14

LFT (4) = LFT (7) – 3 = 27 – 3 = 24 So take LFT (4) = 14

LFT (3) = LFT (6) – 7 = 32 – 7 = 25

LFT (3) = LFT (5) – 1 = 14 – 1 = 13 So take LFT (3) = 13

12. **The network of a construction project is shown in Fig. 4.33 with the estimated durations of various activities. Determine the following.**
(i) Earliest and latest activity time. (ii) Total float for each activity (iii) Critical path for the network.

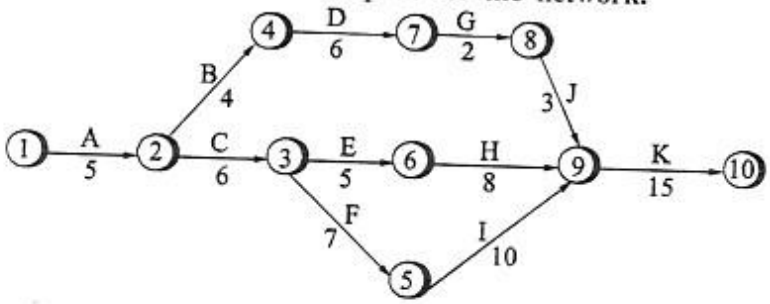


Fig. 4.33

Activity	Earliest Start time (EST)	Latest Start time (LST)	Earliest Finish time (EFT)	Latest Finish time (LFT)	Total Float (LST - EST)
A	0	0	5	5	0
B	5	13	9	17	8
C	5	5	11	11	0
D	9	17	15	23	8
E	11	15	16	20	4
F	11	11	18	18	0
G	15	23	17	25	8
H	16	20	24	28	4
I	18	18	28	28	0
J	17	25	20	28	8
K	28	28	30	30	0

Critial path along A → C → F → J → K 30 days

13. A building project consists of 10 activities with the duration represented by the network diagram shown in Fig 4.34. Compute the earliest and latest activity time and total float for each activity and determine the critical path.

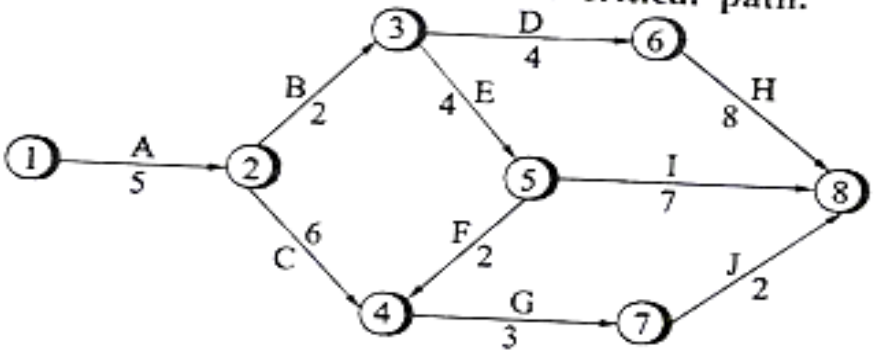


Fig. 4.34

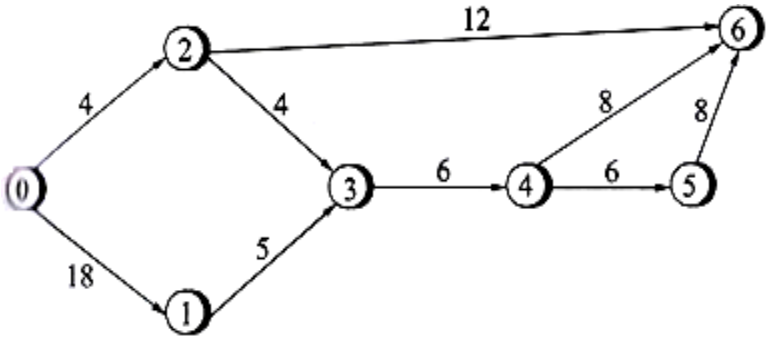


Fig. 4.35

(i) Paths through network

$0 \rightarrow 2 \rightarrow 6 = 4 + 12 = 16$ days

$0 \rightarrow 2 \rightarrow 3 \rightarrow 4 \rightarrow 6 = 4 + 4 + 6 + 8 = 22$ days

$0 \rightarrow 2 \rightarrow 3 \rightarrow 4 \rightarrow 5 \rightarrow 6 = 4 + 4 + 6 + 6 + 8 = 28$ days

$0 \rightarrow 1 \rightarrow 3 \rightarrow 4 \rightarrow 6 = 18 + 5 + 6 + 8 = 37$ days

$0 \rightarrow 1 \rightarrow 3 \rightarrow 4 \rightarrow 5 \rightarrow 6 = 18 + 5 + 6 + 6 + 6 + 8 = 43$ days

(ii) Critical path $= 0 \rightarrow 1 \rightarrow 3 \rightarrow 4 \rightarrow 5 \rightarrow 6$

(iii) Project time $= 43$ days

QUESTION WITH ANSWERS

DEPARTMENT : CIVIL **SEMESTER: V**

SUB.CODE/ NAME: CE 2353 / CONSTRUCTION PLANNING AND SCHEDULING

UNIT- 3 COST CONTROL MONITORING AND ACCOUNTING

(PART A- 2MARKS)

1. Define the term accounting

The process of identifying, measuring and communicating economic information to permit informed judgment and decisions by the use of information.

2. Write the objectives of accounting.

1. To keep systematic records
2. To ascertain the operational profit or loss
3. To facilitate rational decision making
4. To ascertain the financial position of business

3. What are the advantages of accounting? (AUC May/June 2012)

(i) Evidence in court : Properly maintained accounts are often treated as a good evidence in the court to settle a dispute.

(ii) Comparative study : It provided the facility of comparative study of the various aspects of the business such as profits, sales, expenses etc.

(iii) Assistance to various parties : It provides information to various i.e owners, creditors, investors, governmental managers, research scholars and financial position of a business enterprises from their own view point.

4. Define cost accounting

Cost accounting is defined as the process of accounting for cost. It starts from the position at which expenditure is incurred or committed till the establishment of its ultimate relationship with cost centre or cost unit. It involves classification, accumulation, allocation, absorption and control of cost.

5. Write the objectives of cost accounting.

1. To provide unit product cost for inventory valuation and income measurement.
2. To provide actual figures of cost for comparison with estimates and to assiat the management in their price fixing policy.
3. To ascertain cost of production of every unit, job, operation, process, department or service and to develop cost standards.
4. To record and report to the concerned manager how actual costs compare with standard cost and possible causes of difference between them

6. Write the advantages of cost accounting.

(i) Detailed costs of materials, labour and overheads reveals actual and potential sources of cost saving and cost reduction.

(ii) Profit planning and control becomes easier

(iii) Market research and value analysis together with cost reduction programmer lead to economy.

(iv) It helps in creating a competitive spirit between organizational units.

7. Define cost control.

Control of operational involves monitoring activated of the organization and reporting deviation of actual results from those budgeted. Cost control are sought to be kept within limits by budgets and standard

8. Define financial accounting.

The art of recoding, classification and summarizing in a significant manner and in terms of money, transactions and events which are at least in part of financial character and interpreting the results.

9. Compare financial accounting and cost accounting. **(AUC Nov / Dec 2011) (AUC May/June2013)**

	financial accounting	**Cost Accounting**
Users	It provided information to users external to the firm	It provides information to users internal to the firm
Control aspects	Financial accounting does not provide for adequate control aver material wages and overhead costs.	Cost Accounting involve and takes care of control over all elements of cost
Analysis of costs	In financial accounting no distinction is made between direct and indirect cost, fixed cost and variable costs and controllable costs	In cost Accounting, costs are distinguished according to their identification with cost units (Direct and indirect) accounting to their variability (fixed and variable) accounting to responsibility (controllable and uncontrollable) costs
Frequency of reports	Financial accounts are generally published annually	Cost accounts supply quarterly, monthly or even daily cost reports

10. Define the following terms

(i) Cost

(ii) Fixed cost

(iii) Variable cost

(iv) Sunk cost

(v) Controlled cost

(i) Cost: It is the benefits given up to acquire goods or services

(ii) Fixed cost: Cost that remain the same in total irrespective of changes in the level of activity

(iii) Variable cost: Costs that change in total in direct proportion to change in the level of activity.

(iv) Sunk cost: Costs that have already been incurred and are not affected by decisions made in the future.

(v) Controlled cost: Cost that can be directly regulated by a given manager in the organization.

11. What is the purpose of financial accounting?

(i) Internal reporting to project managers for day to planning, monitoring and control

(ii) Internal reporting to managers for aiding strategic planning

(iii) External reporting to owners, government, regulators and other outside parties.

12. Define project budget. (AUC Nov / Dec 2011) (AUC May/June2013)

For cost control on a project, the construction plan and the associated cash flow estimates can provide the baseline reference for subsequent project monitoring and control.

For schedules, progress on individual activated can be compared with the project schedule to monitor the progress of activities.

13. Define the following terms (AUC May/ June 2012)

(i) Budgeted cost (ii) Estimated total cost

(i) Budgeted cost : The budgeted cost is derived from the detailed cost estimate prepared at the start of project.

(ii) Estimated total cost: The estimate or forecast total in each category is the current best estimate of costs based on progress and any changes since the budget was formed.

14. Write the advantages of forecasting activity.

(i) Measurements of actual progress should be stored in actual database and then processed for updating the project schedule.

(ii) It is used to preparing job status reports

(iii) To find out the future revenues, future costs and technical problems.

15. Define cost ratio

The cost incurred to data can also be used to estimate the work progress

Cost ratio = Cost incurred/ total estimated cost.

16. What is the purpose of schedule control?

(i) Project managers must give considerable attention to monitoring schedule.

(ii) It involves for work completion, so contractual agreements will force attention to schedule.

(iii) Delays in construction represent additional costs due to late facility occupancy or other factors.

17. Define balance sheet.

A balance sheet describes the resources that are under a company's on a specified date and indicate where these resources have come from.

18. What are the difference compounds of a balance sheet?

It consists of three major sections

(i) **Assets :** Valuable rights owned by the company

(ii) **Liabilities:** The funds have been provided by outside lenders and other creditors in exchange for the company's promise to make payments or to provide service in the future.

(iii) **The owner's equity:** The funds have been provided by the company's owner or on their behalf.

19. Write short note on schedule control. (AUC Apr/May 2011)

- Project managers must also considerable attention to monitoring schedules
- It involves a dead line for work completion so contractual agreements will force attention to schedule
- Costs are compared to budgeted costs, actual activity durations may be compared to expected durations.

Once estimates of work complete and time expended on particular activities is available estimate can be estimated.

20. List out any 5 indirect cost.

- Temporary utility,
- Cleaning ,
- Unloading ,
- Ware housing ,
- Work shop

21. What is meant by Contigencies?

Contingency is a cushion of cost to deal with uncertainities.Few factors resulting in contingencies are minor design changes,under estimate of cost, lack of experience, unanticipated price changes,safety problems etc.

22. What is meant by Budget?

Budget is an estimate of cost planned to be spent to complete a particular activity.

23. What are the types of cost flow? (AUC May/June 2012)

1) Cash Inflow

2) Cash outflow

24. What is meant by Cost Forecasting?

Cost Forecasting is the requirement of cost to continue with the project at the desired speed.

25. What is meant by Cash Flow control? (AUC May/June 2009)

Cash Flow control is the additional planning required to arrange the cash to meet the demand for the funds.

26. What are the sources of cash inflow? (AUC May/June 2009)

1. Sales of goods,
2. Investment from the owner,
3. Debt financing (loan),
4. Sales of shares

27. What are the sources of cash outflow?

1. Purchase of shares,
2. Payment of dues on loan,
3. Payment of bills,
4. Taxes

28. List out the cost control problems

- Equipment rate variance
- Equipment operating variance
- Labour rate variance
- Material wastages
- Equipment variance
- Other common reasons

29. What are the project cost budget monitoring parameters?

- Budget cost of work Scheduled(BCWS)
- Budget cost of work Performed(BCWP)
- Actual cost of work Performed (ACWP)

30. What are the methods of measuring progress of work?

- Ratio method
- Repetitive type of work progress

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- Non Repetitive complex work progress
- Start/Finish method

31. What are the types of accounting?

1) Financial Accounting
2) Cost Accounting

32. What are the types of Assets?

1) Current Assets
2) Liquid Assets
3) Fixed Assets
4) Intangible Assets

33. What are the types of Liabilities?

1) Current Liabilities
2) Fixed Liabilities

34. Give the hourly Productivity forecasting formula.

Cf=w*hf*ut
Where,
Cf=Total units of work
W=Total units of work
hf=Time Per unit
ut=Cost per unit time

35. What is mean by cost to data? (AUC May/ June 2012)

The actual cost incurred as on date is called cost to date . this forms a part of job – status . it can be derived from the finical record keeping accounts

36. What are the different components of accounting system? (AUC May/ June 2012) (AUC May/ June 2013)

- general ledger
- account payable
- Account receivable journal
- job cost ledgers
- inventory

37. What is Job cost ledgers ? (AUC Apr/May 2010)

Job cost ledgers summarize the charges associated with particular projects, arranged in the various cost accounts used for the project budget.

PART B (16MARKS)

1. Explain Forecasting for Activity Cost Control in detail. (AUC May/ June 2012)

For the purpose of project management and control, it is not sufficient to consider only the past record of costs and revenues incurred in a project. Good managers should focus upon future revenues, future costs and technical problems. For this purpose, traditional financial accounting schemes are not adequate to reflect the dynamic nature of a project. Accounts typically focus on recording routine costs and past expenditures associated with activities. Generally, past expenditures represent sunk costs that cannot be altered in the future and may or may not be relevant in the future.

For example, after the completion of some activity, it may be discovered that some quality flaw renders the work useless. Unfortunately, the resources expended on the flawed construction will generally be sunk and cannot be recovered for re-construction
(although it may be possible to change the burden of who pays for these resources by financial withholding or charges; owners will typically attempt to have constructors or designers pay for changes due to quality flaws). Since financial accounts are historical in nature, some means of forecasting or projecting the future course of a project is essential for management control.

- **Budgeted Cost**
  The budgeted cost is derived from the detailed cost estimate prepared at the start of the project. The factors of cost would be referenced by cost account and by a prose description.
- **Estimated total cost**
  The estimated or forecast total cost in each category is the current best estimate of costs based on progress and any changes since the budget was formed. Estimated total costs are the sum of cost to date, commitments and exposure. Methods for estimating total costs are described below.
- **Cost Committed and Cost Exposure!!**
  Estimated cost to completion in each category in divided into firm commitments and estimated additional cost or exposure.Commitments may represent material orders or subcontracts for which firm dollar amounts have been committed.
- **Cost to Date**
  The actual cost incurred to date is recorded in column 6 and can be derived from the financial record keeping accounts.
- **Over or (Under)**
  A final column in Table 12-4 indicates the amount over or under the budget for each category. This column is an indicator of the extent of variance from the project budget; items with unusually large overruns would represent a particular managerial
  concern. Note that variance is used in the terminology of project control to indicate a difference between budgeted and actual expenditures. The term is defined and used quite differently in statistics or mathematical analysis.

2. Explain the types of Accounting systems in detail . (AUC May/ June 2013)

The cost accounts described in the previous sections provide only one of the various components in a financial accounting system. Before further discussing the use of cost accounts in project control, the relationship of project and financial accounting deserves mention. Accounting information is generally used for three distinct purposes:

- Internal reporting to project managers for day-to-day planning, monitoring and control.
- Internal reporting to managers for aiding strategic planning.
- External reporting to owners, government, regulators and other outside parties.

External reports are constrained to particular forms and procedures by contractual reporting requirements or by generally accepted accounting practices. Preparation of such external reports is referred to as financial accounting. In contrast, cost or managerial accounting is intended to aid internal managers in their responsibilities of planning, monitoring and control. Project costs are always included in the system of financial accounts associated with an organization. At the heart of this system, all expense transactions are recorded in a general ledger. The general ledger of accounts forms the basis for management reports on particular projects as well as the financial accounts for an entire organization. Other components of a financial accounting system include:

- The **accounts payable** journal is intended to provide records of bills received from vendors, material suppliers, subcontractors and other outside parties. Invoices of charges are recorded in this system as are checks issued in payment. Charges to individual cost accounts are relayed or posted to the General Ledger.
- **Accounts receivable** journal provide the opposite function to that of accounts payable. In this journal, billings to clients are recorded as well as receipts. Revenues received are relayed to the general ledger.
- **Job cost ledgers** summarize the charges associated with particular projects, arranged in the various cost accounts used for the project budget.
- **Inventory** records are maintained to identify the amount of materials available at any time.

In traditional bookkeeping systems, day to day transactions are first recorded in journals. With double-entry bookkeeping,each transaction is recorded as both a debit and a credit to particular accounts in the ledger.

For example, payment of a supplier's bill represents a debit or increase to a project cost account and a credit or reduction to the company's cash account. Periodically, the transaction information is summarized and transferred to ledger accounts. This process is called posting, and may be done instantaneously or daily in computerized systems.

In reviewing accounting information, the concepts of flows and stocks should be kept in mind. Daily transactions typically reflect flows of dollar amounts entering or leaving the organization. Similarly, use or receipt of particular materials represent flows from or to inventory. An account balance represents the stock or cumulative amount of funds resulting from these daily flows. Information on both flows and stocks are needed to give an accurate view of an organization's state. In addition, forecasts of future changes are needed for effective management.

3. Explain cash flow control in detail . (AUC Apr/May 2010)

Project managers also are involved with assessment of the overall status of the project, including the status of activities,financing, payments and receipts. These components include costs incurred (as described above), billings and receipts for billings to owners (for contractors), payable amounts to suppliers and contractors, financing plan cash flows (for bonds or other financial instruments), etc. .

In this case, costs are not divided into functional categories , such as labor, material, or equipment. Thus, the aggregation of different kinds of cost exposure or cost commitment has not been performed. The elements include:

•Costs

This is a summary of charges as reflected by the job cost accounts, including expenditures and estimated costs.

•Billings

This row summarizes the state of cash flows with respect to the owner of the facility; this row would not be included for reports to owners.

•Payables

The Payables row summarizes the amount owed by the contractor to material suppliers, labor or sub-contractors.

•Receivables

This row summarizes the cash flow of receipts from the owner. Note that the actual receipts from the owner may differ from the amounts billed due to delayed payments or retainage on the part of the owner.

•Cash Position

This row summarizes the cash position of the project as if all expenses and receipts for the project were combined in a single account. Each of the rows shown in Table 12-8 would be derived from different sets of financial accounts. Additional
reports could be prepared on the financing cash flows for bonds or

4. Explain Schedule control

Construction typically involves a deadline for work completion, so contractual agreements will force attention to schedules. More generally, delays in construction represent additional costs due to late facility occupancy or other factors. Just as costs incurred are compared to budgeted costs, actual activity durations may be compared to expected durations. In this process, forecasting the time to complete particular activities may be required.The methods used for forecasting completion times of activities are directly analogous to those used for cost forecasting.

For example, a typical estimating formula might be:

$$D_f = Wh_t$$

Where **Df** is the forecast duration, **W** is the amount of work, and **ht** is the observed productivity to time t. As with cost control, it is important to devise efficient and cost effective methods for gathering information on actual project accomplishments. Generally, observations of work completed are made by inspectors and project managers and then work completed is estimated. Once estimates of work complete and time expended on particular activities is available, deviations from the original duration estimate can be estimated.

This figure is constructed by summing up the percentage of each activity which is complete at different points in time; this summation can be weighted by the magnitude of effort associated with each activity. In Figure, the project was ahead of the original schedule for a period including point A, but is now late at point B by an amount equal to the horizontal distance
between the planned progress and the actual progress observed to date.

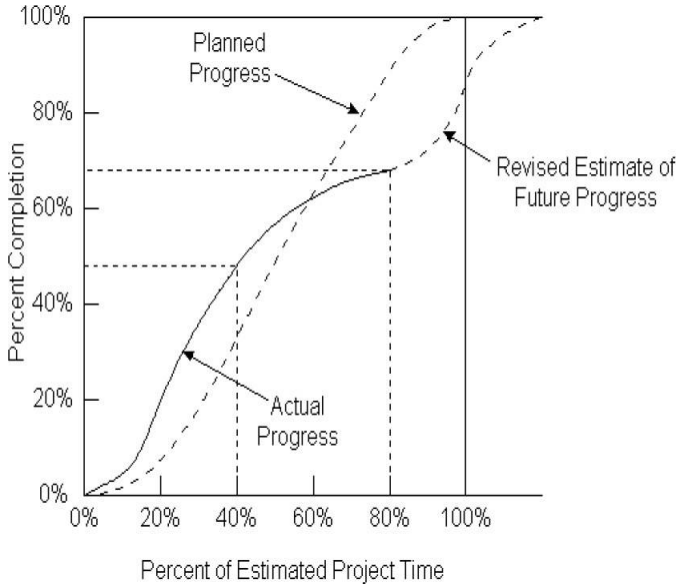


Illustration of Planned versus Actual Progress over Time on a Project

Schedule adherence and the current status of a project can also be represented on geometric models of a facility. In evaluating schedule progress, it is important to bear in mind that some activities possess float or scheduling leeway,whereas delays in activities on the critical path will cause project delays. In particular, the delay in planned progress at time t may be soaked up in activities' float (thereby causing no overall delay in the project completion) or may cause a project delay. As a result of this ambiguity, it is preferable to update the project schedule to devise an accurate portrayal of the schedule adherence. After applying a scheduling algorithm, a new project schedule can be obtained.

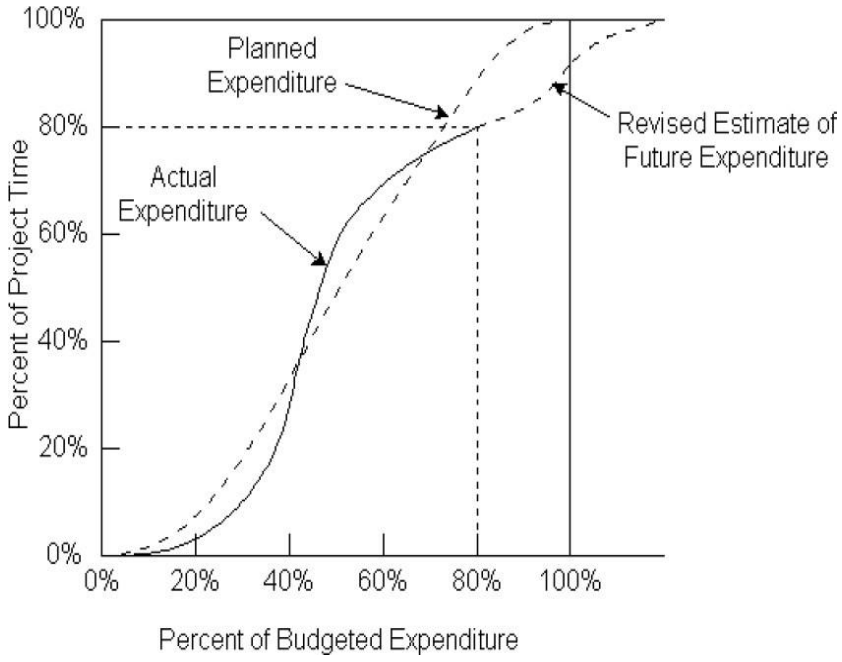


Illustration of Planned versus Actual Expenditures on a Project

5. Explain the Project budget.

For cost control on a project, the construction plan and the associated cash flow estimates can provide the baseline reference for subsequent project monitoring and control. For schedules, progress on individual activities and the achievement of milestone completions can be compared with the project schedule to monitor the progress of activities.

Contract and job specifications provide the criteria by which to assess and assure the required quality of construction. The final or detailed cost estimate provides a baseline for the assessment of financial performance during the project. To the extent that costs are within the detailed cost estimate, then the project is thought to be under financial control. Overruns in particular cost categories signal the possibility of problems and give an indication of exactly what problems are being encountered. Expense oriented construction planning and control focuses upon the categories included in the final cost estimation. This focus is particular relevant for projects with few activities and considerable repetition such as grading and paving roadways.

For control and monitoring purposes, the original detailed cost estimate is typically converted to a project budget, and the project budget is used subsequently as a guide for management. Specific items in the detailed cost estimate become job cost elements. Expenses incurred during the course of a project are recorded in specific job cost accounts to be compared with the original cost estimates in each category. Thus, individual job cost accounts generally represent the basic unit for cost control. Alternatively, job cost accounts may be disaggregated or divided into work elements which are related both to particular scheduled activities and to particular cost account. In addition to cost amounts, information on material quantities and labor inputs within each job account is also typically retained in the project budget. With this information, actual materials usage and labor employed can be compared to the expected requirements. As a result, cost overruns or savings on particular items can be identified as due to changes in unit prices, labor productivity or in the amount of material consumed. The number of cost accounts associated with a particular project can vary considerably. For constructors, on the order of four hundred separate cost accounts might be used on a small project. These accounts record all the transactions associated with a project. Thus, separate accounts might exist for different types of materials, equipment use, payroll, project office, etc. Both physical and non-physical resources are represented, including overhead items such as computer use or interest charges.

6. Explain the Completed- contract and percentage – of completion methods in detail. (AUC May / June 2012) (AUC Apr/May 2010)

Information from the general ledger is assembled for the organization finical reports , including balance sheets and income statements for each period . these reports are the basic products of the financial accounting system and are often used to assess the performance of an organization .

In the case of private construction firms , some problems arise in the treatment of completed contracts in financial reports . under the " completed – contract " method income is only reported for completed projects . Work on projects underway is only reprted on the balance sheet . this represents as an asset if contract billings . When a project is completed, the total net profit (or loss) is reported in the final period as income . Under the " percentage of – completion method " actual

costs are reported on the income statement plus a proportion of all project revenues (or billings) equal to the the proportion of the work completed as the ratio of costs incurred to date the total estimated cost of the project.

The “percentage of completion “method reporting period earnings has the advantages of representing the actual estimated earnings in each period . Because of this in the income And the resulting profits are less susceptiable to precipitate sayings on the completion of a project as on occur with the completed contract method of calculating income . percentage of completion accountings provides only a rough estimate of the actual profit or status of a project . also “ completed – contract method “ is entirely retrospective and provides no guidance for management . however , the “ percentage of completion “ has the disadvantages of relying upon estimate can be manipulated to obscure then actual position of a company or which are difficult reproduce by outside observers.

7, Explain the different stages of cost control in detail.

1. **Pre-cost contract stages :**

(i) During the design stages :

Every effort should be made of at the design stage itself to provide the most economical section consistent section with project requirement.

(ii) Planning of specifications :

(iii) Maximum useof locally available materials and their specifications are to be incorporated in the design to arrive at the economical .

2. **Post – contract stages :**

1. Construction material are to be inspected at service so that chances of defective materials being uncorrected in the work eliminated .
2. Adopting suitable quantity buying policy such that unwanted expenditure on the transport .
3. Proper super vision of labour with adequate supervision officers.
4. Appreciating laborers who give additional output by labour.
5. continued valuation of output .
6. avoiding idle- hours of equipment.
7. maintaining always a minimum over – accidents .
8. taking safety measures to avoid accidents .
9. taking adequate security measures to avoid theft of materials.
10. a well – plannad and organized repair workshop to keep the equipment always in working condition.

8. Explain the job cost accounts in details .

Specific items in the detailed cost estimate or project budget become job – cost elements . expenses incurred during the course of a project on a job are recorded in specific job – cost account . thus is compared with the original cost estimates in each category . thus individual job cost account generally represent the basic unit for cost control

In the project budget , aparty from the cost amounts information on materials qualities and the labour Inputs are retained with this information usage of actual materials and labour .employed can be compared to the expected requirements. This enables to assess the cost over – runs or savings on particular items

Number of cost accounts associated with a particular project can vary consisderly . thus separate accounts might exist for different materials , use of equipments , pay – roll , project office . etc \

The main accounts of a typical building construction project in table . the details comprise of men mai9n events , sitye clearance and site preparation , substructure , outside utilizes , superstructure , pavings , equipment installed and compound wall.

Account no,	Activity
001	Site-clerence
002	Substructure
003	Outside utilities
004	Superstructure
005	Paving , curbs
006	Equipment installed
007	Compound wall or fencing

The above account is organized hierarchically , with seven major division . under each major division there may be members subdivision . the hierarchical structure facilities aggregation of in to pre defined categories .

Fpr example , costrs associated with substructure (account 002) would be the sum of the underlying subdivisions

02.1 excavation and shoring
02.2 foundation
02.3 concrete masonry
02.31 concrete mixing and placing
02.32 formwork
02.33 reinforcement

Similiarly , subdivision for major division have to be identified and account numbers are given .

In the developing or implementing a system of cost accounts are appropriate numbering or coding system in essential . such a system will facilitate communication of information and proper aggregation of cost information.

QUESTION WITH ANSWERS

DEPARTMENT : CIVIL **SEMESTER: V**

SUB.CODE/ NAME: CE 2353 / CONSTRUCTION PLANNING AND SCHEDULING

UNIT- 4 QUALITY CONTROL AND SAFETY DURING CONSTRUCTION

(PART A- 2MARKS)

1. Define Acceptance Quality Level(AQL)

AQL is defined as the maximum percent defectives that for the purpose of samples inspection can be considered satisfactory as a progress average.

2. Define quality circle. (AUC May/June 2013) (AUC Nov/Dec 2010)(AUC Apr/May 2010) (AUC Nov/Dec 2011) (AUC May/June 2009)

Quality circle is a small group of people doing similar work who meet regularly Identify, analyze and solve problems related to their workplace.

3. Define attribute.

When the data obtained for analysis is only a number of articles conforming and the number failing to conform to any specific requirement, the quality is said to be an attribute.

4. Define variable

Variable is the quality characteristic actually measured using a measuring instrument and expressed as a number on some continuous scale of measurement. A single measurement quality characteristic such as dimension, weight and volume is called a variable.

5. 6. What are the types of statistical sampling? (AUC Apr/May 2010)

1. Sampling by attributes
2. Sampling by variables

1. Sampling by attributes

The acceptance or rejection of a lot is based on the number of defective (bad) or a non defective item in the sample .This is referred to as sampling by attributes.

2. Sampling by variables

Instead of using defective and non defective classifications for an item, a quantitative quality measure or the value of a measured variable is used as a quality indicator. This testing procedure is referred to as sampling by variables

7. What are the standard measures in safety construction?

a. Requiring hard hats on site
b. Requiring eye protection on site
c. Requiring hearing protection near equipment
d. Insuring safety shoes for workers
e. Providing First-Aid supplies and trained personnel on site.

8. What are the various temporary safeguards in construction?

It involves maintaining temporary physical safeguards such as

1. Barricades

2. Braces
3. Guy lines
4. Railings
5. Toe boards

9. How do you improve in jobsite in construction?

Various measures are available to improve jobsite safety in construction several of the most important occur before construction is undertake These include

1. Design
2. Choice of technology
3. Educating workers
4. Pre-qualification of contractors

10. How do you improve in total control?

- To improve worker enthusiasm
- To reduced defective items
- To increased costs of inspection
- To improved quality even Without endorsing the goal of zero defects
- To insure safe and effective construction procedures are a major element.
- To improved quality control is often formalized in quality circle
- All materials should be certified and inspected regularly

11. What are the material specifications available in construction? (AUC Apr/May 2011)

General specifications of work quality are available fields and are issued in publications of organizations such as

1. The American Society for Testing and Materials (ASTM)
2. The American National Standards Institute (ANSI)
3. Construction Specification Institute (CSI)
4. American Welding Society (AWS)

12. What are the factors affecting in quality in construction? (AUC Apr/May 2013)

1. Incorrect design
2. Improper workmanship
3. Lack of attention in worksite
4. Poor conformance material quality
5. Lack of training in construction work
6. Improper safeguards

13. Define quality

Quality is defined as the fitness for the purpose and its satisfies the customer.

14. What are the steps involved in total quality control?

Total quality control is a commitment to quality expressed in all parts of an organization and typically involves many elements

1. Design reviews to insure safe and effective construction procedure
2. Training for personnel
3. Shifting the responsibility for detects and defects from quality control inspectors to workers.
4. Material suppliers are also require to insure zero defects in delivered goods

15. **Define accident**. **(AUC May/June 2012)**

Accident is an unpleasant incident that happens unexpectedly or an accident is an incident that happens by chance.

16. What are the standards measured in safety construction?

- Provide Helmets for workers
- Requiring Eye Protection
- Requiring Hearing Protection
- Supply Safety Shoes
- Provide First Aid facility

17. **What are the various temporary Safeguards in construction**?

- Guy lines
- Barricades
- Braces
- Railings
- Toe Boards

18. How do you improve the job site in construction?

- Design
- choice of technology
- Educating workers
- Pre-qualification of contractors

19. What do you mean by Sampling by attributes?

The acceptance and rejection of a lot is based on the number of defective Or a non defective item in the sample. This is referred to as sampling by attribute.

20.. How do you improve in total control?

1) To improve worker enthusiasm
2) To reduce the defective items
3) To increase the cost of items
4) To insure safe and effective construction

21. What is the material Specifications available in construction?

1) The American Society for Testing and materials (ASTM)
2) The American National Standards Institute (ANSI)
3) Construction Specification Institute (CSI)
4) American Welding Society (AWS)

22. What are the factors affecting Quality in construction?

1) Incorrect Design
2) Improper workmanship
3) Lack of attention in worksite
4) Lack of training in construction work

23. Define Quality.

Quality is defined as the fitness for the purpose and it satisfies the Customer.

24. Mention the causes of Accident in a construction industry. (AUC May/June 2009) (AUC Apr/May 2010)

1) Physical Accident
2) Physiological Accident

3) Psychological Accident

25. What are the functions of Inspection?

1) Material Inspection
2) Process Inspection
3) Equipment Inspection
4) Finished Job Inspection

26. **What are the Various Safety equipments?**

- Helmet
- Gloves
- Shoes
- Goggles
- Safety Belts

27. **Mention two safeties Quotation.**

- Make safety a habit
- Good work is a Safe work

28. **What are the technical services required for inspection?**

1) Engineers/Designers/Arghitect/Geologists
2) Supervisors
3) Scientists
4) Technicians
5) Field Laboratory
6) Base Laboratory
7) Equipment testing and repair unit

29. Mention the Physical causes of Accident in a construction industry.

- Accidents caused due to Machines
- Accidents caused due to tools
- Accidents caused due to materials
- Accidents caused due to uniform
- Accidents caused in working environment.

30. Define total quality control. (AUC Apr/May 2010)

- Quality control in construction involves insuring compliance with minimum standards of material and workmanship in order to insure the performance of the facility according to the design.
- For the purpose of insuring compliance random samples and statistical methods are commonly used as the basis for accepting or rejecting work completed and batches of materials.

31. Distinguish between producers risk and consumer risk. (AUC May/June 2013)
(AUC Nov/Dec 2011)

To determine the probalities that acceptable lots might be incorrectly rejected which is termed producers risk. On the other to determine the probabilities that deficient for might be incorrectly accepted which is formed as consumer' risk.

(PART B- 16MARKS)

1. Explain Statistical Quality Control with Sampling by Attributes. (AUC May/June 2009) (AUC Nov/Dec 2011) (AUC Apr/May 2010)

Sampling by attributes is a widely applied quality control method. The procedure is intended to determine whether or not a particular group of materials or work products is acceptable. In the literature of statistical quality control, a group of materials or work items to be tested is called a lot or batch. An assumption in the procedure is that each item in a batch can be tested and classified as either acceptable or deficient based upon mutually acceptable testing procedures and acceptance criteria. Each lot is tested to determine if it satisfies a minimum acceptable quality level (AQL) expressed as the maximum percentage of defective items in a lot or process.

In its basic form, sampling by attributes is applied by testing a pre-defined number of sample items from a lot. If the number of defective items is greater than a trigger level, then the lot is rejected as being likely to be of unacceptable quality. Otherwise, the lot is accepted. Developing this type of sampling plan requires consideration of probability, statistics and acceptable risk levels on the part of the supplier and consumer of the lot. Refinements to this basic application procedure are also possible. More formally, a lot is defined as acceptable if it contains a fraction p1 or less defective items. Similarly, a lot is defined as unacceptable if it contains a fraction p2 or more defective units. Generally, the acceptance fraction is less than or equal to the rejection fraction, p1 p2, and the two fractions are often equal so that there is no ambiguous range of lot acceptability between p1 and p2. Given a sample size and a trigger level for lot rejection or acceptance, we would like to determine the probabilities that acceptable lots might be incorrectly rejected (termed producer's risk) or that deficient lots might be incorrectly accepted (termed consumer's risk).

Consider a lot of finite number N, in which m items are defective (bad) and the remaining (N-m) items are non-defective (good). If a random sample of n items is taken from this lot, then we can determine the probability of having different numbers of defective items in the sample. With a pre-defined acceptable number of defective items, we can then develop the probability of accepting a lot as a function of the sample size, the allowable number of defective items, and the actual fraction of defective items. This derivation appears below.

The number of different samples of size n that can be selected from a finite population N is termed a mathematical combination and is computed as:

$$\binom{N}{n} = \frac{N(N-1)\ldots(N-n+1)}{n!} = \frac{N!}{n!(N-n)!}$$

where a factorial, n! is n*(n-1)*(n-2)...(1) and zero factorial (0!) is one by convention.

The number of possible samples with exactly x defectives is the combination associated with obtaining x defectives from m possible defective items and n-x good items from Nm good items:

$$\binom{m}{x}\binom{N-m}{n-x} = \frac{m!}{x!(m-x)!} \times \frac{(N-m)!}{(n-x)!(N-m-n+x)!}$$

Given these possible numbers of samples, the probability of having exactly x defective items in the sample is given by the ratio as the hypergeometric series:

$$P(X=x) = \frac{\binom{m}{x}\binom{N-m}{n-x}}{\binom{N}{n}}$$

With this function, we can calculate the probability of obtaining different numbers of defectives in a sample of a given size.

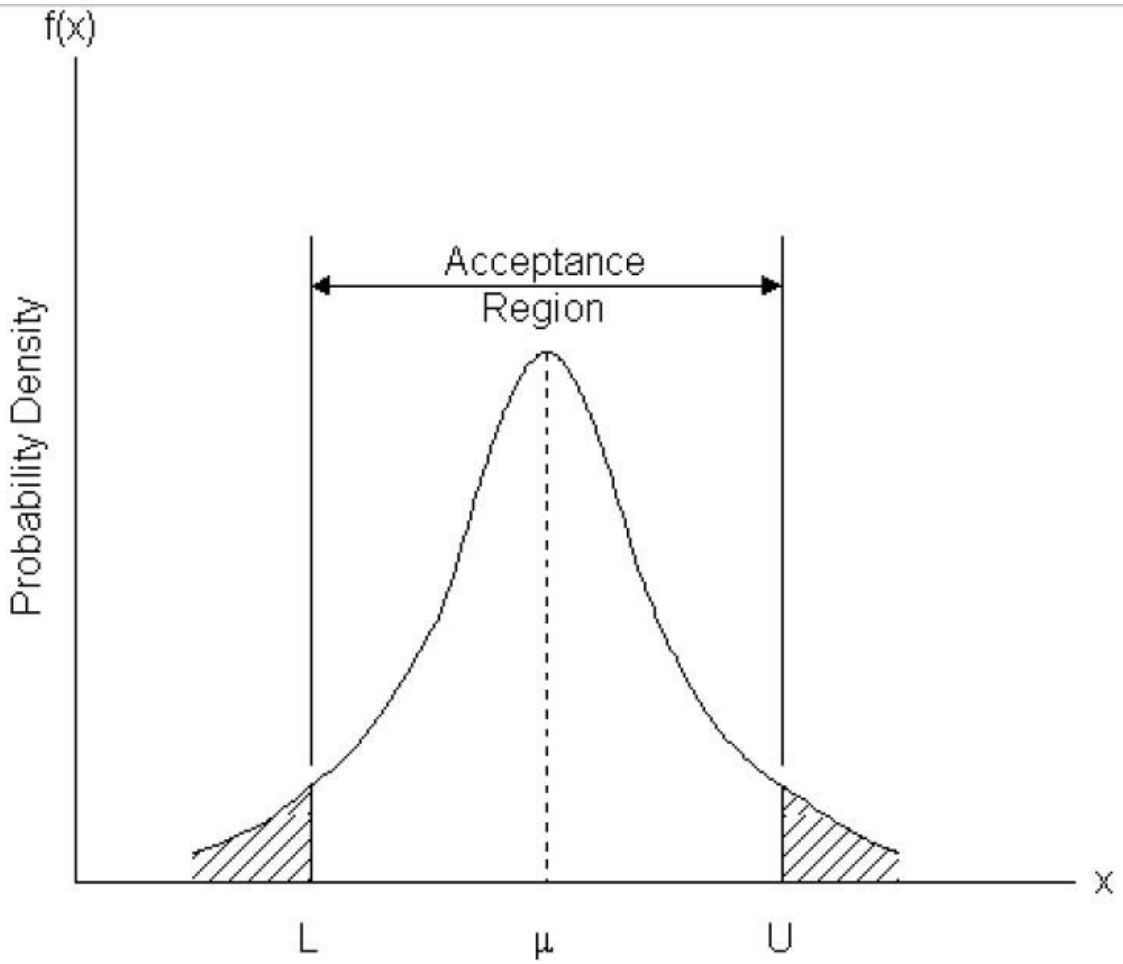
2. Explain Statistical Quality Control with Sampling by Variables. (AUC May/June 2013)

Many work and material attributes possess continuous properties, such as strength, density or length. With the sampling by attributes procedure, a particular level of a variable quantity must be defined as acceptable quality. More generally, two items classified as good might have quite different strengths or other attributes. Intuitively, it seems reasonable that some "credit" should be provided for exceptionally good items in a sample. Sampling by variables was developed for application to continuously measurable quantities of this type. The procedure uses measured values of an attribute in a sample to determine the overall acceptability of a batch or lot. Sampling by variables has the advantage of using more information from tests since it is based on actual measured values rather than a simple classification. As a result, acceptance sampling by variables can be more efficient than sampling by attributes in the sense that fewer samples are required to obtain a desired level of quality control.

In applying sampling by variables, an acceptable lot quality can be defined with respect to an upper limit U, a lower limit L, or both. With these boundary conditions, an acceptable quality level can be defined as a maximum allowable fraction of defective items, M. With an upper limit U, the fraction of defective items is equal to the area under the distribution function to the right of U (so that x U). This fraction of defective items would be compared to the allowable fraction M to determine the acceptability of a lot. With both a lower and an upper limit on acceptable quality, the fraction defective would be the fraction of items greater than the upper limit or less than the lower limit. Alternatively, the limits could be imposed upon the acceptable average level of the variable

Variable

Variable Probability Distributions and Acceptance Regions

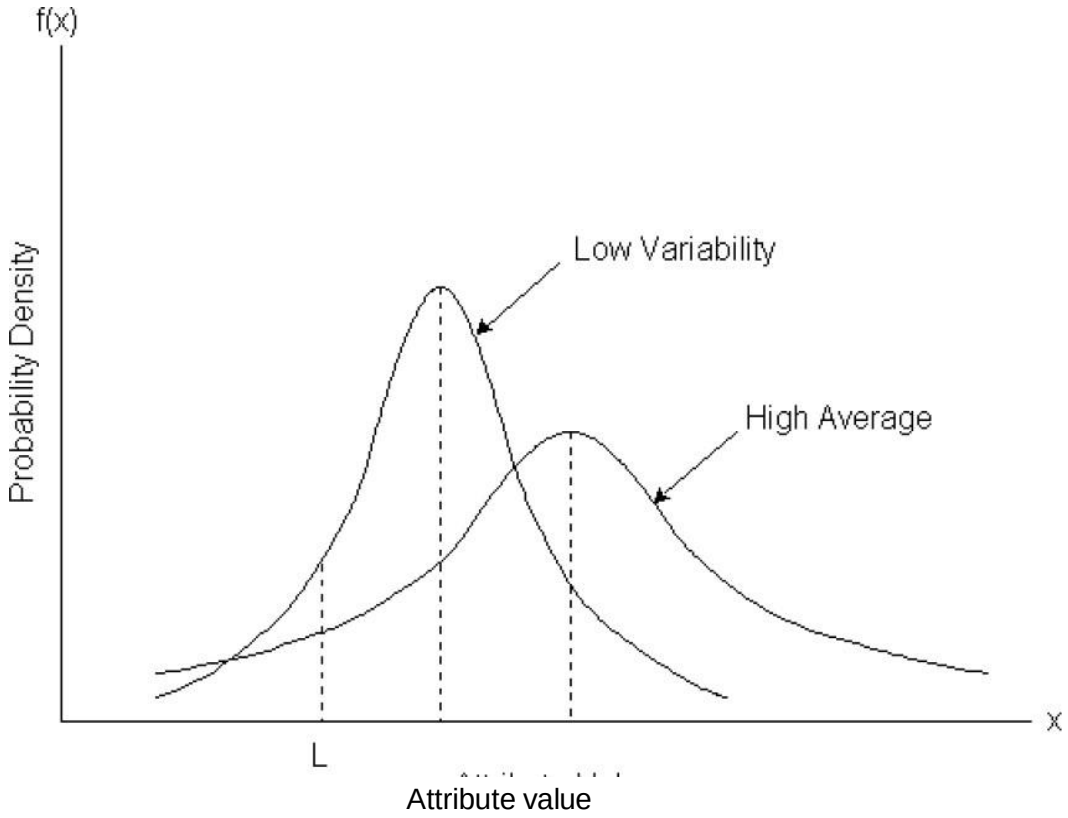


In sampling by variables, the fraction of defective items is estimated by using measured values from a sample of items. As with sampling by attributes, the procedure assumes a random sample of a give size is obtained from a lot or batch. In the application of sampling by variables plans, the measured characteristic is virtually always assumed to be normally distributed . The normal distribution is likely to be a reasonably good assumption for many measured characteristics such as material density or degree of soil compaction. The Central Limit Theorem provides a general support for the assumption: if the source of variations is a large number of small and independent random effects, then the resulting distribution of values will approximate the normal distribution. If the distribution of measured values is not likely to be approximately normal, then sampling by attributes should be adopted. Deviations from normal distributions may appear as skewed or non-symmetric distributions, or as distributions with fixed upper and lower limits.

The fraction of defective items in a sample or the chance that the population average has different values is estimated from two statistics obtained from the sample: the sample mean and standard deviation. Mathematically, let n be the number of items in the sample

and xi, i = 1,2,3,...,n, be the measured values of the variable characteristic x. Then an estimate of the overall population mean is the sample mean

$$\mu \approx \bar{x} = \frac{1}{n}\sum_{i=1}^{n} x_i$$



Testing for Defective Component Strengths.

3. Discuss some of the safety requirements of construction Industry. (AUC May/June 2012) (AUC May/June 2009) (AUC Apr/May 2010) (AUC Apr/May 2011)

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. These work related injuries and illnesses are exceedingly costly.. In contrast to most industrial accidents, innocent bystanders may also be injuried by construction accidents. Several crane collapses from high rise buildings under construction have resulted in fatalities to passersby. Prudent project managers and owners would like to

reduce accidents, injuries and illnesses as much as possible.
As with all the other costs of construction, it is a mistake for owners to ignore a significant category of costs such as injury and illnesses. While contractors may pay insurance premiums directly, these costs are reflected in bid prices or contract amounts. Delays caused by injuries and illnesses can present significant opportunity costs to owners. In the long run, the owners of constructed facilities must pay all the costs of construction. For the case of injuries and illnesses, this general principle might be slightly qualified since significant costs are borne by workers themselves or society at large. However, court judgements and insurance payments compensate for individual losses and are ultimately borne by the owners.Various measures are available to improve jobsite safety in construction. Several of themost important occur before construction is undertaken. These include design, choice oftechnology and education. By altering facility designs, particular structures can be saferor more hazardous to construct. For example, parapets can be designed to appropriate heights for construction worker safety, rather than the minimum height required by building codes.
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. For example, simple switches can prevent equipment from being operating when protective shields are not in place. With the availability of on-board electronics (including computer chips) and sensors, the possibilities for sophisticated machine controllers and monitors has greatly expanded for construction equipment and tools. Materials and work process choices also influence the safety of construction. For example, substitution of alternative materials for asbestos can reduce or eliminate the prospects of long term illnesses such as asbestiosis.Educating workers and managers in proper procedures and hazards can have a direct impact on jobsite safety. The realization of the large costs involved in construction injuries and illnesses provides a considerable motivation for awareness and education. Regular safety inspections and safety meetings have become standard practices on most job sites.Pre-qualification of contractors and sub-contractors with regard to safety is another important avenue for safety improvement. If contractors are only invitied to bid or enter negotiations if they have an acceptable record of safety (as well as quality performance), then a direct incentive is provided to insure adequate safety on the part of contractors. 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. Vigilance involves considering the risks of different working practices. In also involves maintaining temporary physical safeguards such as barricades, braces, guy lines, railings, toeboards and the like. Sets of standard practices are also important, such as:

- requiring hard hats on site.
- requiring eye protection on site.
- requiring hearing protection near loud equipment.
- insuring safety shoes for workers.
- providing first-aid supplies and trained personnel on site

While eliminating accidents and work related illnesses is a worthwhile goal, it will never be attained. Construction has a number of characteristics making it inherently hazardous. Large forces are involved in many operations. The jobsite is continually changing as construction proceeds. Workers do not have fixed worksites and must move around a

structure under construction. The tenure of a worker on a site is short, so the worker's familiarity and the employer-employee relationship are less settled than in manufacturing settings. Despite these peculiarities and as a result of exactly these special problems, improving worksite safety is a very important project management concern.

4. Explain Quality control and safety during construction. (AUC May/June 2012)

Quality control and safety represent increasingly important concerns for project managers. Defects or failures in constructed facilities can result in very large costs. Even with minor defects, re-construction may be required and facility operations impaired. Increased costs and delays are the result. In the worst case, 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. Good project managers try to ensure that the job is done right the first time and that no major accidents occur on the project.eAs with cost control, the most important decisions regarding the quality of a completed facility 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. Quality control during construction consists largely of insuring conformance to these original designs and planning decisions.

While conformance to existing design decisions is the primary focus of quality control, there are exceptions to this rule. First, unforeseen circumstances, incorrect design decisions or changes desired by an owner in the facility function may require reevaluation of design decisions during the course of construction. While these changes may be motivated by the concern for quality, they represent occasions for re-design with all the attendant objectives and constraints. As a second case, some designs rely upon informed and appropriate decision making during the construction process itself. For example, some tunneling methods make decisions about the amount of shoring required at different locations based upon observation of soil conditions during the tunneling process. Since such decisions are based on better information concerning actual site conditions, the facility design may be more cost effective as a result.

With the attention to conformance as the measure of quality during the construction process, the specification of quality requirements in the design and contract documentation becomes extremely important. Quality requirements should be clear and verifiable, so that all parties in the project can understand the requirements for conformance. Much of the discussion in this chapter relates to the development and the implications of different quality requirements for construction as well as the issues associated with insuring conformance.

Safety during the construction project is also influenced in large part by decisions made during the planning and design process. Some designs or construction plans are inherently difficult and dangerous to implement, whereas other, comparable plans may considerably reduce the possibility of accidents. For example, clear separation of traffic from construction zones during roadway rehabilitation can greatly reduce the possibility of accidental collisions. Beyond these design decisions, safety largely depends upon education, vigilance and cooperation during the construction process. Workers should be constantly alert to the possibilities of accidents and avoid taken unnecessary risks.

Organizing for Quality and Safety

A variety of different organizations are possible for quality and safety control during construction. One common model is to have a group responsible for quality assurance and another group primarily responsible for safety within an organization. In large organizations, departments dedicated to quality assurance and to safety might assign specific individuals to assume responsibility for these functions on particular projects. For smaller projects, the project manager or an assistant might assume these and other responsibilities. In either case, insuring safe and quality construction is a concern of the project manager in overall charge of the project in addition to the concerns of personnel, cost, time and other management issues.

Inspectors and quality assurance personnel will be involved in a project to represent a variety of different organizations. Each of the parties directly concerned with the project may have their own quality and safety inspectors, including the owner, the engineer/architect, and the various constructor firms. These inspectors may be contractors from specialized quality assurance organizations. In addition to on-site inspections, samples of materials will commonly be tested by specialized laboratories to insure compliance. Inspectors to insure compliance with regulatory requirements will also be involved. Common examples are inspectors for the local government's building department, for environmental agencies, and for occupational health and safety agencies.

5. Explain the main causes of accidents. list the specific standard practices to be followed in the work site to have safety of individual. (AUC May/June 2013)

Main causes of accidents in civil engineering works have been analyzed by different organizations based on the statistics released by the statutory bodies . the study reveals the basic causes of accidents in civil engineering construction in the order of seriousness are as follows :

- Persons falling from height
- Persons being struck or trapped by moving object .
- Persons stepping on or striking against object
- Persons handling objects in such a way so to to cause injury .
- Person usins hand tools
- Other causes .
- There is an increase in the frequency of accident in case of new employees especially during the first year of service.

The following set of standard practices are necessary for safety of individuals ,(i) insuring safety shoes for workers on site

(ii) Requiring hard hats on site

(iii) Requiring hearing protection near loud equipment .

(iv) providing first – aid supplies and trained personal on site .

6. **Explain the various safety measures in detail. (AUC Nov/Dec 2011) (AUC Apr/May 2011)**

The various measures are available to improve jobsite safety in construction. These incude design , choice of technology and education . by altering certain facility designs , safety measures may be improved . for example , parapets , can be designed to appropriate heights for construction worker safety , rather than the minimum height required by buildings codes .

Choice of technology can also be determining the safety of a jobsite . safeguards built in to machinery can notify operators of problem or prevent injuries with the availability of on board electronics and sensors / machine operations may be better controlled . Materials and work process choices also influence materials for the safety of the construction . for example , substitution of alternate materials for asbestos can reduce or prevent illnesses such as abestiosts.

There shall be direct impact on jobsite safety by properly educating workrs and managers on onsite safety procedures workers and managers on site safety procedures and hazards . the realization of the large costs involved due to illness and injuries should bring unawareness and education and education of workers and managers on safety measures on safety measures regular have become standard practices on most job sites .

Another important avenue for safety adaptation in worksites is pre-qualifications of contractors and subcontractors with regard to safety. That is only contractors who could provide acceptable safety measures are to be invited to bid or enter acceptable safety measures are to invited to bid or enter negotiations.

Another the most important safety related measures are to insure vigilance and cooperation on the part of managers , inspectors and workers during the construction period.

(i) Insuring safety shoes for workers on site

(ii) Requiring hard hats on site

(iii) Requiring hearing protection near loud equipment

(iv) Providing first aud supplies and trained personnel on site.

7 , **Explain the Indian construction industry requires a comprehensive legislation fpr the Safety. And welfare of its workman "comment on the statement". (AUC May/June 2012)**

In the general the execution of works is coverd under the safety health codes. National building code of Indian , deals with the entire gamunt of building construction from by – laws to installation of services and laying down regulations . the code prescribes a set of minimumprovision for the design to ensure the safety of the public with regard to structural sufficiency , fire hazards and occupational health hazards .

there are also other prescribed legislations concering occupational safety and health in construction and building industry .specific safety norms are laid for electrical safety , safety in use of explosives and various types of construction machinery, etc.

in the india the building and other construction workers act 1996 and central rule 1998 , cover the statutory measures to be ensured by employer to ensure safety of workers at construction sites . according to these regulations , the empoyers has the sole responsibility for the statutory requriments are included in the contract documents and from part good construction practices . in addition to legislation and regulations periodic inspections by authorities onsafety measures and testing of construction equipment are made . yet because of certain deficiencies in these legislation and loop in the inspecting mechanism many accidents remain unanimated undetected.

India national commission on labour recommended for a comprehensive legislation , covering , welfare , safety and other aspects of working conditions in the construction industry .

QUESTION WITH ANSWERS

DEPARTMENT : CIVIL **SEMESTER: V**

SUB.CODE/ NAME: CE 2353 / CONSTRUCTION PLANNING AND SCHEDULING

UNIT- 5 ORGANIZATIONS AND USE OF PROJECT INFORMATION

(PART A- 2MARKS)

UNIT-V

1. What are types of project information? **(AUC Apr/May 2010)**

- Cash flow and procurement accounts for each organization
- Intermediate analysis resulting during planning and design
- Design document, including drawings and specifications
- Construction schedules and cost estimates
- Quality control and assurance records
- Construction field activity and inspection logs
- Legal contracts and regulatory documents

2. Write the use of project information in construction. **(AUC Nov/Dec2011)**

- To find out the overall growth of the project.
- An historical record may be important for use during operation, to assess responsibilities in case of facility failure or for planning similar projects.
- The control and flow of information also important for collaborative work environment may professionals are working on difference aspect of a project and sharing information.
- Information provided for sharing data files tracing decisions and communication via electronic mail or video conferencing.
- To understand the scope alternatives for organizing project information.

3. Define database and DBM. **(AUC May /June2012) (AUC Apr/May 2011)**

Database: Database is a collection of stored operational information used by the management and application systems of some particular enterprise.

DBM:DBM is the software program that directors the storage, maintenance, manipulation and retrieval of data users retrieve or store data by issuing specific request to the DBM. The objective of introducing a DBM is to free the user from the detail of exactly how data are stored and manipulated,

4. What is meant by database administrator?

Database administrator is an individual or group charged with the maintenance and design of the database, including approving access to the stored information. In large organization with many users, the database administrator is vital to the success of the database systems. For small projects, the database administrator might be an assistant project manager or ever the project manager

5. What are the advantages relational models of databases?

- Flexibility
- Efficiency
- Reduces the redundancy
- Manipulation is easy
- Alternatives views or external models of the information.

6. Define hierarchical model.

The hierarchical model is a tree structure in which information is organized as branches and nodes from a particular base. It has the characteristic that each items has a single predecessors and a variable number of subordinate data items.

7. What are the advantages of centralized management systems?

(i) Reduced redundancy: Good planning can allow duplicate or similar data stored in different files for different applications to be combined and stored only once
(ii) Improved availability: Information may be made available to any application program through the use of the DBM
(iii) Reduced inconsistency: If the data is stored in more than one place, then updating in one place and not everywhere can lead to inconsistencies in the database.
(iii) Enforced data security: Authorization to use information can be centralized.

8. What are the application programs in DBM? (AUC Apr/May 2011) (AUC Nov/Dec2011)

- Data is drawn from the central database as needed by individual programs
- Information request are typically performed by including predefined function calls to the database management system within an application program.
- One program are stored in the database and can be used by subsequent programs without specialized translation routines.

9. Define data dictionary

Data dictionary contains the definitions of the information in the database.
Data dictionary are limited to descriptions as the information source for anything dealing with the database systems. The data dictionary may be contain user authorization specifying who may have access to particular pieces of information

10. What is the main feature of database?

- Database can serve the role of storing a library of information on standard architectural features and compound properties.
- These standard compounds can be called from the database library and induced into a new design
- The database can also store the description of a new design, such as number, type and location of building components

11. What are the advantages of integrated application systems? (AUC Apr/May 2011)

- Communicate with a single database
- Integrated system without extensive modifications to existing programs
- The use of integrated systems with open success to a database is not common for construction activities at the current time.

12. What are the disadvantages of centralized database management systems?

1. Central database systems may be expansive and cumbersome that it becomes ineffective
2. Manual information management can also expansive
3. Installing and maintaining database costly
4. A single database is particularly vulnerable to equipment failure.

13. Define network model. (AUC May /June2009)

The network model or database organization retains the organization of information on branches and nodes, but does not require a tree of structure. It gives grater flexibility but does not necessarily provide ease of access to all data items.

14. Define relational model

The relational model is defined as one possible relation to record unit cost data associated with particular activities, included in the database would be one row for each of the various items involved in construction or other project activities.

15. Why is accuracy in information necessary? (AUC Nov/Dec2010)

Various types of errors creep from the starting till the end in a project. in accuracy may cause a delay in construction and increase cost of construction . Thus the following errors should be avoided:

(i) Numerical values are often reported often reported to the nearest cost of values
(ii) If the value of inaccuracy in low, the workers generally skip and do not report .
(iii) Inaccuracy may also come from transcription errors of variable sorts
(iv) Typographical errors , incorrect measurement from reading equipment
(v)Calculations errors .

16. List any four software's used for project management. (AUC May /June2012)

(i) INSTAPLAN
(ii) PRISM
(iii) MS PROJECT
(iv) YOJANA

(PART B- 16MARKS)

1. Explain how the information can be organized using computers.
(AUC May /June2009) (AUC Apr/May 2011) (AUC Nov/Dec2011)

Numerous formal methods and possible organizations exist for the information required for project management. Before discussing the details of computations and information representation, it will be useful to describe a record keeping implementation, including some of the practical concerns in design and implementation. In this section, we shall describe a computer based system to provide construction yard and warehouse management information from the point of view of the system users. In the process, the usefulness of computerized databases can be illustrated. In typical construction warehouses, written records are kept by warehouse clerks to record transfer or return of equipment to job sites, dispatch of material to jobs, and maintenance histories of particular pieces of equipment. In turn, these records are used as the basis for billing projects for the use of equipment and materials.

For example, a daily charge would be made to a project for using a concrete pump. During the course of a\month, the concrete pump might spend several days at different job sites, so each

project would be charged for its use. The record keeping system is also used to monitor materials and equipment movements between sites so that equipment can be located. Equipment movements would have to be tracked individually, days at each site counted, and the daily charge accumulated for each project. This project would be charged a daily rental rate until the grinder was returned. Hundreds or thousands of individual item
transfers would have to be examined, and the process of preparing bills could easily require a week or two of effort.In addition to generating billing information, a variety of reports would be useful in the process of managing a company's equipment and individual projects. Records of the history of use of particular pieces of equipment are useful for planning maintenance and deciding on the sale or scrapping of equipment. Reports on the cumulative amount of materials and equipment delivered to a job site would be of obvious benefit to project managers. Composite reports on the amount, location, and use of pieces of equipment of particular types are also useful in making decisions about the purchase of new equipment, inventory control, or for project planning. Unfortunately, producing each of these reports requires manually sifting through a large number of transfer cards. Alternatively, record keeping for these specific projects could have to proceed by keeping multiple records of the same information. For example, equipment transfers might be recorded on (1) a file for a particular piece of equipment and (2) a file for a particular project, in addition to the basic transfer form. Even with these redundant records, producing the various desired reports would be time consuming.
Finally, flexibility of systems for changes is an important design and implementation concern. New reports or views of the data are a common requirement as the system is used. For example, the introduction of a new accounting system would require changes in the communications procedure from the warehouse inventory system to record changes and other cost items.In sum, computerizing the warehouse inventory system could save considerable labor,speed up billing, and facilitate better management control. Against these advantages mustbe placed the cost of introducing computer hardware and software in the warehouse.

2. **Explain the database management systems.** **(AUC May /June2013)**
(AUC May /June2009)

With the advent of micro-computer database managers, it is possible to develop formal, computerized databases for even small organizations and projects. In this section, we will discuss the characteristics of such formal databases. Equivalent organization of information for manual manipulation is possible but tedious. Computer based information systems also have the significant advantage of rapid retrieval for immediate use and, in most instances, lower overall costs. For example, computerized specifications writing systems have resulted in well documented savings. These systems have records of common specification phrases or paragraphs which can be tailored to specific project applications.
Formally, a database is a collection of stored operational information used by the management and application systems of some particular enterprise. This stored information has explicit associations or relationships depending upon the content and definition of the stored data, and these associations may themselves be considered to be part of the database. Figure illustrates some of the typical elements of a database. The internal model is the actual location and representation of the stored data. At some level of detail, it consists of the strings of "bits" which are stored in a computer's memory, on

the tracks of a recording disk, on a tape, or on some other storage device.

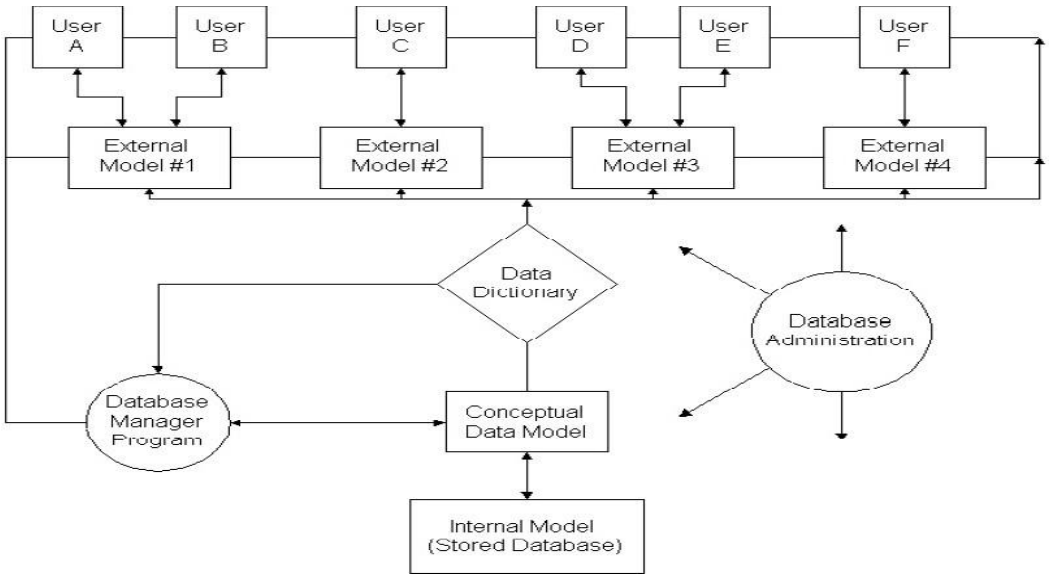


Figure Illustration of a Database Management System Architecture

A manager need not be concerned with the details of data storage since this internal representation and manipulation is regulated by the Database Manager Program (DBM). The DBM is the software program that directs the storage, maintenance, manipulation and retrieval of data. Users retrieve or store data by issuing specific requests to the DBM. The objective of introducing a DBM is to free the user from the detail of exactly how data are stored and manipulated. At the same time, many different users with a wide variety of needs can use the same database by calling on the DBM. Usually the DBM will be available to a user by means of a special query language. For example, a manager might ask a DBM to report on all project tasks which are scheduled to be underway on a particular date. The desirable properties of a DBM include the ability to provide the user with ready access to the stored data and to maintain the integrity and security of the data. Numerous commercial DBM exist which provide these capabilities and can be readily adopted to project management applications.

While the actual storage of the information in a database will depend upon the particular machine and storage media employed, a Conceptual Data Model exists which provides the user with an idea or abstract representation of the data organization. (More formally, the overall configuration of the information in the database is called the conceptual schema.) For example, a piece of data might be viewed as a particular value within a record of a datafile. In this conceptual model, a datafile for an application system consists of a series of records with pre-defined variables within each record. A record is simply a sequence of variable values, which may be text characters or numerals. This datafile model is one of the earliest and most important data organization structures. But other views of data organization exist and can be exceedingly useful. The next section describes one such general model, called the relational model.

Continuing with the elements in Figure, the data dictionary contains the definitions of the information in the database. In some systems, data dictionaries are limited to descriptions of the items in the database. More general systems employ the data dictionary as the

information source for anything dealing with the database systems. It documents the design of the database: what data are stored, how the data is related, what are the allowable values for data items, etc. The data dictionary may also contain user authorizations specifying who may have access to particular pieces of information. Another important element of the data dictionary is a specification of allowable ranges for pieces of data; by prohibiting the input of erroneous data, the accuracy of the database improves.

External models are the means by which the users view the database. Of all the information in the database, one particular user's view may be just a subset of the total. A particular view may also require specific translation or manipulation of the information in the database. For example, the external model for a paycheck writing program might consist solely of a list of employee names and salary totals, even if the underlying database would include employee hours and hourly pay rates. As far as that program is concerned, no other data exists in the database. The DBM provides a means of translating particular external models or views into the overall data model. Different users can view the data in quite distinct fashions, yet the data itself can be centrally stored and need not be copied separately for each user. External models provide the format by which any specific information needed is retrieved. Database "users" can be human operators or other application programs such as the paycheck writing program mentioned above.

Finally, the Database Administrator is an individual or group charged with the maintenance and design of the database, including approving access to the stored information. The assignment of the database administrator should not be taken lightly. Especially in large organizations with many users, the database administrator is vital to the success of the database system. For small projects, the database administrator might be an assistant project manager or even the project manager

3. Explain Centralized Database Management Systems. (AUC Apr/May 2010)

A datafile consists of a set of records arranged and defined for a single application system. Relational information between items in a record or between records is not explicitly described or available to other application systems. For example, a file of project activity durations and scheduled times might be assembled and manipulated by a project scheduling system. This datafile would not necessarily be available to the accounting system or to corporate planners.

A centralized DBM has several advantages over such stand-alone systems:

- **Reduced redundancy** good planning can allow duplicate or similar data stored in different files for different applications to be combined and stored only once.
- **Improved availability** information may be made available to any application program through the use of the DBM
- **Reduced inconsistency** if the same data is stored in more than one place, then updating in one place and not everywhere can lead to inconsistencies in the database.
- **Enforced data security** authorization to use information can be centralized.

For the purpose of project management, the issue of improved availability is particularly important. Most application programs create and own particular datafiles in the sense that

information is difficult to obtain directly for other applications. Common problems in attempting to transfer data between such special purpose files are missing data items, unusable formats, and unknown formats.

As an example, suppose that the Purchasing Department keeps records of equipment rental costs on each project underway. This data is arranged so that payment of invoices can be handled expeditiously and project accounts are properly debited. The records are arranged by individual suppliers for this purpose. These records might not be particularly useful for the purpose of preparing cost estimates since:

- Some suppliers might not exist in the historical record.
- Finding the lowest cost supplier for particular pieces of equipment would be exceedingly tedious since every record would have to be read to find the desired piece of equipment and the cost.
- No direct way of abstracting the equipment codes and prices might exist.

An alternative arrangement might be to separately record equipment rental costs in (1) the Purchasing Department Records, (2) the Cost Estimating Division, and (3) the Company warehouse. While these multiple databases might each be designed for the individual use, they represent considerable redundancy and could easily result in inconsistencies as prices change over time. With a central DBM, desired views for each of these three users could be developed from a single database of equipment costs.

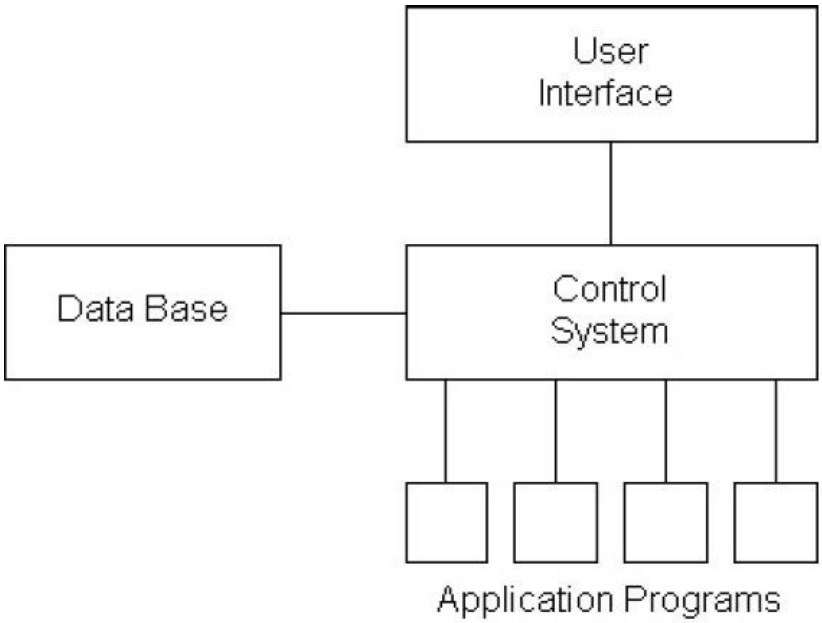
A manager need not conclude from this discussion that initiating a formal database will be a panacea. Life is never so simple. Installing and maintaining databases is a costly and time consuming endeavor. A single database is particularly vulnerable to equipment failure. Moreover, a central database system may be so expensive and cumbersome that it becomes ineffective; we will discuss some possibilities for transferring information between databases in a later section. But lack of good information and manual information management can also be expensive.

One might also contrast the operation of a formal, computerized database with that of a manual filing system. For the equipment supplier example cited above, an experienced purchasing clerk might be able to immediately find the lowest cost supplier of a particular piece of equipment. Making this identification might well occur in spite of the formal organization of the records by supplier organization. The experienced clerk will have his (or her) own subjective, conceptual model of the available information. This subjective model can be remarkably powerful. Unfortunately, the mass of information required, the continuing introduction of new employees, and the need for consistency on large projects make such manual systems less effective and reliable.

Databases and Applications Programs

The usefulness of a database organization is particularly evident in integrated design or management environments. In these systems, numerous applications programs share a common store of information. Data is drawn from the central database as needed by individual programs. Information requests are typically performed by including predefined function calls to the database management system within an application program. Results from one program are stored in the database and can be used by subsequent programs without specialized translation routines. Additionally, a user interface usually exists by which a project manager can directly make queries to the database. Figure illustrates the role of an integrated database in this regard as the central data store.

Illustration of an Integrated Applications System



4. Explain Information transfer and flow.

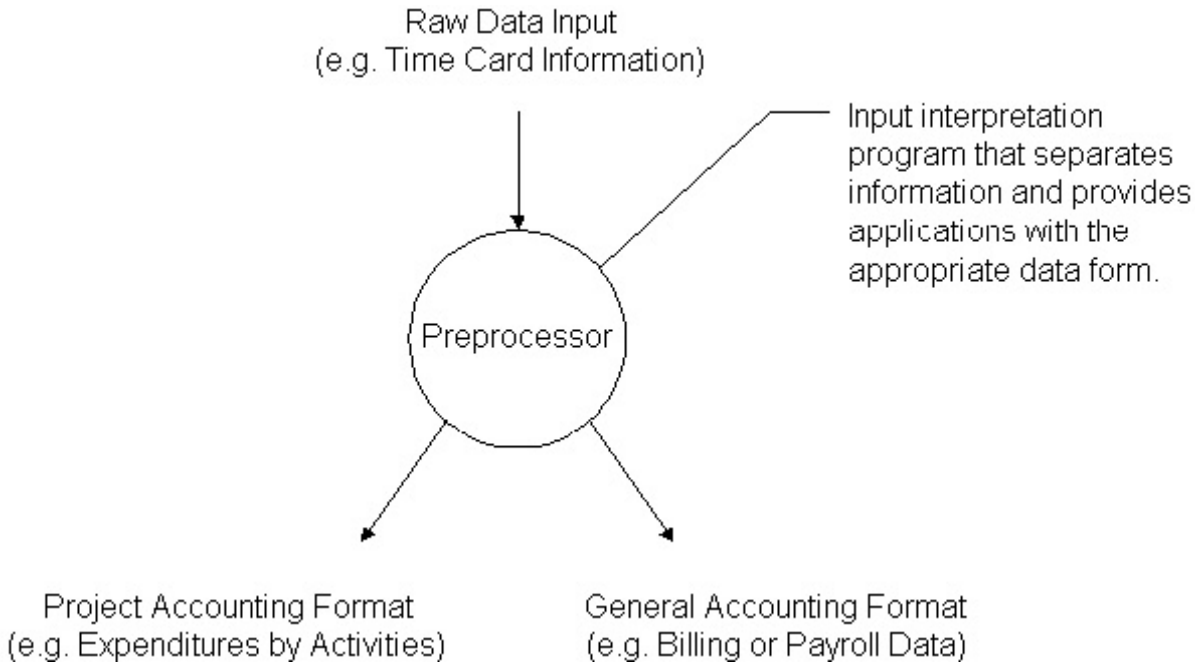
In an overabundance of optimism or enthusiasm, it might be tempting to conclude that all information pertaining to a project might be stored in a single database. This has never been achieved and is both unlikely to occur and undesirable in itself. Among the difficulties of such excessive centralization are:

- **Existence of multiple firms or agencies involved in any project.** Each organization must retain its own records of activities, whether or not other information is centralized. Geographic dispersion of work even within the same firm can also be advantageous. With design offices around the globe, fast track projects can have work underway by different offices 24 hours a day.
- **Advantages of distributed processing.** Current computer technology suggests that using a number of computers at the various points that work is performed is more cost effective than using a single, centralized mainframe computer. Personal computers not only have cost and access advantages, they also provide a degree of desired redundancy and increased reliability.
- **Dynamic changes in information needs.** As a project evolves, the level of detail and the types of information required will vary greatly.
- **Database diseconomies of scale.** As any database gets larger, it becomes less and less efficient to find desired information.
- **Incompatible user perspectives.** Defining a single data organization involves trade-offs between different groups of users and application systems. A good organization for one group may be poor for another.

In addition to these problems, there will always be a set of untidy information which cannot be easily defined or formalized to the extent necessary for storage in a database. While a single database may be undesirable, it is also apparent that it is desirable to

structure independent application systems or databases so that measurement information need only be manually recorded once and communication between the database might exist. Consider the following examples illustrating the desirability of communication between independent application systems or databases. While some progress has occurred, the level of integration and existing mechanisms for information flow in project management is fairly primitive. By and large, information flow relies primarily on talking, written texts of reports and specifications and drawings.

Application of an Input Pre-processor



Application of an Input Pre-processor

Final Cost Estimation, Scheduling and Monitoring

Many firms maintain essentially independent systems for final cost estimation and project activity scheduling and monitoring. As a result, the detailed breakdown of the project into specific job related activities must be completely re-done for scheduling and monitoring. By providing a means of rolling-over or transferring the final cost estimate, some of this expensive and time-consuming planning effort could be avoided.

Design Representation

In many areas of engineering design, the use of computer analysis tools applied to facility models has become prevalent and remarkably effective. However, these computer-based facility models are often separately developed or encoded by each firm involved in the design process. Thus, the architect, structural engineer, mechanical engineer, steel fabricator, construction manager and others might all have separate computer-based representations of a facility. Communication by means of reproduced facility plans and prose specifications is traditional among these groups. While transfer of this information in a form suitable for direct computer processing is difficult, it offers obvious advantages in avoiding repetition of work, delays and transcription.

5. Explain the problems in information system management in detail. .

(AUC May /June2012)

(i) Unaware of the need :

Information need of managers varies. it depends on the level at which they are operating and the function within which they are operating and function within which they are operating . only a very few organizations have made deliberate efforts to identify specific information needs of various managerial positions . generally there exists a gap between the actual requirements and actually available to the managers .

(ii) Information irretrievability:

Some projects do generate useful and necessary data. They are often in a form or location that makes it uneconomical and unfeasible to retrieve. If such information cannot be accessed, this might lead to wastage of effort. Information can go out of control when it is held in different media, using different. These could be from different sources, levels, languages and locations.

(iii) Misinterpreted information :

Such a problem arises doe to different sources within the organization or due to excessive pressure on the source to collect information is not read in proper context, a leads to poor and ineffective decision . Misunderstood information can have a negative effect.

(iv) Accumulation of information:

This caused due to system having grown with the growth and diversificication of the organization. Sometimes. people tend to make extra copies just in case its get lost . This duplication adds to the cost . Further overloads cause major communication problems.

(v) Hiding of information :

Some people hide information and are reluctant to share it with others

(vi) Resistance to change :

Some people do not easily swith over to new change of technology but keep on doing on their old ways .some are reluctant to witness the obsolescence of their skills

(vii) Delays of information :

There is some gap between the occurrence of event and the information reaching the concerned person , sometimes dates are not moved and processed fast enough to allow enough time for managers to reactquickly in time . it may so happen than when the datas are made available to them they may have no values .

6. Explain the computerized organization and use of information in detail. .
(AUC May /June2012) (AUC Apr/May 2010)

With the increase in protect sizes , it becomes difficult and at times even impossible to plan , schedule , budget and control project activities using techniques . hence for large

project the task is made easier with the use computers .

for projects of bigget sizes and complex nature it is necessary to adopt . computerized project management system . the advantages of using CPMS are as under :

1. Compared to manual analysis a CPMS is capable of analyzing the problem at a very high speed . because of its high speed , any number of permutations and combinations can be handled .
2. Large and complex projects by CPMS are accurate and can be reeled upon.
3. Results produced by CPMS are accurate and can be relied upon .
4. A CPMS reduce the human resource requirement considerably.
5. It is possible for the project manager himself can directly interact with the computer instead of depending on his subordinates .

A typical example of a computer based management system is a construction yard or warehouse management information . A yard or a warehouses is used by most construction firms to store equipment and to provide an inventory of materials and parts needed for projects . large firms may have transit time between project sites and on the job site . local yards would be drills , saws , trailers , graders concrete pumps , cranes , etc . minerals items might include nails , plywood , wire mesh , forming lumber.

In typical consrruction warehouses , written records are kept by warehouses clerks to records transfer or return of equipment to job sites dispatch of materials to jobs , and maintence of histories of ptricular piece of equipment . as a matter of fact all these details are used as the basis for the billing projects for the uses of equipment and materials , such record keeping system is a must in every project . further record keeping is also used to monitor materials and equipment movements between sites so the equipment can be located . all these details can be programmed for the local conditions or any standards software on warehouses inventory may be used .

In addition to generating billing information a varity of reports would br useful in the process of managing a companys equipment and individual projects detail for preparation of such report could be made available from the computer information allows warehouses personal both to ask questions and get the necessary answer.

7. Explain the types of project information? Write the use of project information in Construction. . (AUC May /June2013) (AUC Nov/Dec2011)

1. Cash flow and procurement accounts for each organization
2. Intermediate analysis resulting during planning and design
3. Design document, including drawings and specifications
4. Construction schedules and cost estimates
5. Quality control and assurance records
6. Construction field activity and inspection logs
7. Legal contracts and regulatory documents
8. Regulatory documents

- To find out the overall growth of the project.
- An historical record may be important for use during operation, to assess responsibilities in case of facility failure or for planning similar projects.
- The control and flow of information also important for collaborative work environment may professionals are working on difference aspect of a project and sharing information.
- Information provided for sharing data files tracing decisions and communication via electronic mail or video conferencing.
- To understand the scope alternatives for organizing project information.

As the project proceeds some of these sites of information are evolved. Some information sets are important at one stage of the process. but may then be ignored . Common example in planning or structural or structural analysis databases. Which are not ordinarily used during construction or operation. However, it may be necessary at large in the project to re-do analysis and important needed changes . in this case contented information storage and retrieval become important . Even after the completion of the construction, a historical report has to be prepared. such reports may be during operation to asses responsibilities in case of facility failures or for planning similar projects

Control an flow of construction is also important for joint works. joint work s joint environments provide factilities for sharing data flies , training decisions and communication may become very large .

Appreciable cost will be involved with the generation , storage , transfer , retrieval and other maintence . the cost will be significantly increased due to inaccurate or missing information . in addition to the costs of decisional work there will be large investment on computers and other peripherals . Such a huge cost is the rare resource on any construction project. Hence it is worthwhile to explore the scope and alter nativities for organizing project information .

UNIT I - CONSTRUCTION PLANNING			
Basic concepts in the development of construction plans-choice of Technology and Construction method-Defining Work Tasks- Work breakdown structure – Definition- Precedence relationships among activities-Estimating Activity Durations-Estimating Resource Requirements for work activities-coding systems.			
PART A			
Q.NO	**QUESTIONS**	**BT LEVEL**	**COMPETENCE**
1.	Name any two coding systems used in the construction industry.	BT-1	Remembering
2.	Prepare a flow chart representing the role of planning in different stages.	BT-1	Remembering
3.	Write any two objectives of planning.	BT-1	Remembering
4.	Explain briefly the precedence relationship among activities.	BT-1	Remembering
5.	What are the necessities of planning?	BT-1	Remembering
6.	List out the significance of coding system.	BT-1	Remembering
7.	Discuss about the construction planning.	BT-2	Understanding
8.	State activity precedence with an example.	BT-2	Understanding
9.	Differentiate activity and event.	BT-2	Understanding
10.	List out the uses of coding system.	BT-2	Understanding
11.	Define work task.	BT-1	Remembering
12.	Classify the different project planning techniques.	BT-1	Remembering
13.	Describe the significance of choice of technology.	BT-1	Remembering
14.	List out project planning techniques?	BT-1	Remembering
15.	Identify the various resources used for construction project.	BT-2	Understanding
16.	Explain the process involved in planning.	BT-2	Understanding
17.	How will you estimate the activity duration?	BT-1	Remembering
18.	Explain the basic concepts involved in development of construction plan.	BT-1	Remembering
19.	Summarize the learning curve and define the different phases of learning.	BT-1	Remembering
20.	What is the difference between time oriented scheduling and resource oriented scheduling?	BT-1	Remembering
21.	What do you mean by fast track approach in construction?	BT-1	Remembering
22.	What is planning?	BT-1	Remembering

23.	What are the types of project plan?	BT-1	Remembering
24.	List the role of project managers on construction management?	BT-2	Understanding
PART B			
1.	Explain in detail about the estimation of activity durations and importance of learning curves.	BT-3	Applying
2.	Write short notes on i. Choice of construction technology (7) ii. Choice of construction method (6)	BT-3	Applying
3.	Prepare a generalized report on stages of planning by different agencies.	BT-3	Applying
4.	Define the precedence relationship among various activities and justify the relationship.	BT-3	Applying
5.	Describe the importance of coding system of activities with examples.	BT-3	Applying
6.	List out the factors deciding activity durations.	BT-3	Applying
7.	Explain the procedure to formulate activity network with suitable example.	BT-3	Applying
8.	i. Write down the importance of construction planning. (7) ii. What are the steps involved in planning? (6)	BT 5	Evaluating
9.	How do you specify precedence relationship in activity on node and activity on branch network?	BT 3	Applying
10.	How will you estimate the resources for work activities?	BT 3	Applying
11.	i. Define WBS (3) ii. Draw a typical WBS tree diagram for residence building construction. (10)	BT 3	Applying
12.	i. Describe the role of planning in the different stages of a Project? (7) ii. Mention the types of plan and objectives of planning? (6)	BT 3	Applying
13.	Explain with reference to a high rise building comparing cast-in-situ and precast construction methods for the RCC structure.	BT 3	Applying
14.	Define construction planning. Explain in detail about the basic concept involved in the development of construction plan.	BT-3	Applying
15.	Explain the procedure of the estimating the resource requirements for activities.	BT 3	Applying

16.	Explain the stages development of construction planning in detail.	BT 3	Applying
17.	Explain the advantages and limitation of planning.	BT 3	Applying
	PART C		
1.	Describe in detail the relationship between choice of technology – construction method and the project time frame and budget limitations.	BT-3	Applying
2.	What are the different methods to estimate the time duration of activities?	BT 5	Evaluating
3.	Demonstrate the precedence definition for site preparation and foundation work.	BT 5	Evaluating
4.	Prepare work breakdown and activity network for a tunnelling project by defining the precedence relationship.	BT-3	Applying
5.	List down the major steps in planning a project. Explain in detail about the three natures of plans encountered in a typical construction project.	BT 5	Evaluating

UNIT II - SCHEDULING PROCEDURES AND TECHNIQUES

Relevance of construction schedules-Bar charts - The critical path method-Calculations for critical path scheduling and PERT -Activity float and schedules-Presenting project schedules Critical path scheduling for Activity-on-node and with leads, Lags and Windows- Resource oriented scheduling-Scheduling with resource constraints and precedences -Use of Advanced Scheduling Techniques-Scheduling with uncertain durations-Calculations for Monte Carlo Schedule Simulation- Crashing and time/cost tradeoffs -Improving the Scheduling process – Introduction to application software(Primavera, MS Project)

PART – A

Q.NO	QUESTIONS	BT LEVEL	COMPETENCE
1.	Write down the significance of critical path?	BT 1	Remembering
2.	Prepare a network for the given activity.	BT 1	Remembering

Event	Immediate predecessor	Event	Immediate predecessor
1	-	6	3,5
2	1	7	3,4
3	2	8	3,7
4	2	9	7
5	2	10	3,6,8,9

3.	Compare CPM and PERT	BT 1	Remembering

<table>
<tr><td>4.</td><td>Define the terms: -
i) Dummy activity ii) EST iii) EFT</td><td>BT 1</td><td>Remembering</td></tr>
<tr><td>5.</td><td>Define and differentiate between float and slack.</td><td>BT 1</td><td>Remembering</td></tr>
<tr><td>6.</td><td>How will you create an activity node and activity event.</td><td>BT 1</td><td>Remembering</td></tr>
<tr><td>7.</td><td>How you will estimate the expected time for an activity.</td><td>BT 2</td><td>Understanding</td></tr>
<tr><td>8.</td><td>Define the terms: - i) LFT ii) LST</td><td>BT 2</td><td>Understanding</td></tr>
<tr><td>9.</td><td>List the types of networks.</td><td>BT 2</td><td>Understanding</td></tr>
<tr><td>10.</td><td>What are the three time estimates used for determining the activity duration in pert procedure?</td><td>BT 2</td><td>Understanding</td></tr>
<tr><td>11.</td><td>What are the steps involved in schedule chart?</td><td>BT 1</td><td>Remembering</td></tr>
<tr><td>12.</td><td>List out the factors affecting scheduling.</td><td>BT 1</td><td>Remembering</td></tr>
<tr><td>13.</td><td>Discuss about the constraints in scheduling.</td><td>BT 1</td><td>Remembering</td></tr>
<tr><td>14.</td><td>Explain the terms total float and independent float.</td><td>BT 2</td><td>Understanding</td></tr>
<tr><td>15.</td><td>Write down the necessity of resources oriented scheduling.</td><td>BT 1</td><td>Remembering</td></tr>
<tr><td>16.</td><td>Distinguish between crash cost and crash time.</td><td>BT 2</td><td>Understanding</td></tr>
<tr><td>17.</td><td>Discuss about the purpose of numbering events?</td><td>BT 1</td><td>Remembering</td></tr>
<tr><td>18.</td><td>Explain resource leveling and crashing.</td><td>BT 1</td><td>Remembering</td></tr>
<tr><td>19.</td><td>State the reason why resource oriented scheduling is necessary.</td><td>BT 2</td><td>Understanding</td></tr>
<tr><td>20.</td><td>Define activity cost slope.</td><td>BT 3</td><td>Applying</td></tr>
<tr><td>21.</td><td>What is called time limited schedule</td><td>BT 2</td><td>Understanding</td></tr>
<tr><td>22.</td><td>What is resource limited schedule</td><td>BT 1</td><td>Remembering</td></tr>
<tr><td>23.</td><td>Define resource construct.</td><td>BT 2</td><td>Understanding</td></tr>
<tr><td>24.</td><td>Differentiate activity and node.</td><td>BT 2</td><td>Understanding</td></tr>
<tr><td colspan="4">PART – B</td></tr>
<tr><td>1.</td><td>The duration of activities of a project is as follows. Draw the PERT network diagram. Identify various paths. Identify the critical path. Tabulate the computations. Evaluate the project time?
<table>
<tr><td>Activity</td><td>1-2</td><td>1-3</td><td>2-4</td><td>2-5</td><td>4-7</td><td>5-7</td><td>7-8</td><td>3-6</td><td>6-8</td></tr>
<tr><td>Duration in days</td><td>5</td><td>10</td><td>1</td><td>6</td><td>12</td><td>3</td><td>4</td><td>7</td><td>6</td></tr>
</table>
</td><td>BT 4</td><td>Analyzing</td></tr>
</table>

<table>
<tr><td>2.</td><td>Explain in relation to network analysis, the terms critical activity, non-critical activity, independent float and free float?</td><td>BT 3</td><td>Applying</td></tr>
<tr><td>3.</td><td>Draw the network and design the critical path and calculate the ES, EF, LS and LF of the project whose activities are as follows.
<table>
<tr><th>ACTIVITY</th><th>DURATION IN DAYS</th><th>PRECEDING ACTIVITY</th></tr>
<tr><td>A-B</td><td>7</td><td>-</td></tr>
<tr><td>B-C</td><td>10</td><td>A-B</td></tr>
<tr><td>B-D</td><td>15</td><td>A-B</td></tr>
<tr><td>C-D</td><td>7</td><td>B-C</td></tr>
<tr><td>C–E</td><td>12</td><td>B-C</td></tr>
<tr><td>D-E</td><td>3</td><td>B-D,C-D</td></tr>
<tr><td>E-F</td><td>5</td><td>C-E,D-E</td></tr>
</table></td><td>BT 3</td><td>Applying</td></tr>
<tr><td>4.</td><td>The activities of a project are listed below, draw the network diagram and find out the critical path. Find the completion time of the project. Calculate EST, EFT, LST, LFT and mark in the diagram calculated total float and free float, Tabulate the details.
<table>
<tr><td rowspan="2">Activity item</td><td rowspan="2">Duration in days</td><td colspan="2">Activities immediately</td></tr>
<tr><td>Preceding</td><td>Following</td></tr>
<tr><td>A</td><td>3</td><td>-</td><td>B,C</td></tr>
<tr><td>B</td><td>4</td><td>A</td><td>D</td></tr>
<tr><td>C</td><td>6</td><td>A</td><td>D</td></tr>
<tr><td>D</td><td>3</td><td>B, C</td><td>D,E</td></tr>
<tr><td>E</td><td>6</td><td>C</td><td>G</td></tr>
<tr><td>F</td><td>4</td><td>D</td><td>I</td></tr>
<tr><td>G</td><td>5</td><td>E</td><td>H,J</td></tr>
<tr><td>H</td><td>3</td><td>G</td><td>I</td></tr>
<tr><td>I</td><td>6</td><td>F,H</td><td>L</td></tr>
<tr><td>J</td><td>4</td><td>G</td><td>K</td></tr>
<tr><td>K</td><td>4</td><td>J</td><td>L</td></tr>
<tr><td>L</td><td>4</td><td>I,K</td><td>-</td></tr>
</table></td><td>BT 4</td><td>Analyzing</td></tr>
<tr><td>5.</td><td>
<table>
<tr><td>Activity</td><td>A</td><td>B</td><td>C</td><td>D</td><td>E</td><td>F</td><td>G</td><td>H</td><td>I</td><td>J</td><td>K</td></tr>
</table></td><td>BT 3</td><td>Applying</td></tr>
</table>

Predecessor	-	-	A	A	B	B	E	C,G	C,G	F,H	D,I,J
Duration (Days)	10	12	8	12	6	5	8	8	10	6	12

1. Draw the project network and identify the critical path. (5)
2. Calculate all the activity times (EST, EFT, LST and LFT) (5)
3. Calculate TOTAL FLOAT and FREE FLOAT for all the activities. (3)

6.	The details of a network are given below, where the durations are in days. Find the critical path and project completion time.	BT 3	Applying

Activity	A	B	C	D	E	F	G	H	I
Predecessor	-	-	A	A	B,C	B,C	D,E	D,E	F,G
Duration (Days)	4	3	8	7	9	12	2	5	6

7.	Calculate the critical path and all the floats by constructing activity on branch network?	BT 4	Analyzing

Activity	A	B	C	D	E	F	G
Predecessor	-	A	A	A	D	C,E	D,F
Duration (Days)	3	6	16	10	8	5	3

8.	(i) Define and differentiate between CPM and PERT. (7) (ii) Compare "Precedence network analysis and critical path method? (6)	BT 4	Analyzing
9.	Determine the minimum cost and optimum duration for the following project. The data of each activity of network is given in the table. Indirect cost is Rs.4000/week.	BT 4	Analyzing

ACTIVITY	**NORMAL**		**CRASH**	
	TIME (month)	**COST(Rs)**	**TIME (month)**	**COST(Rs)**
0-1	3	5000	2	5500
1-3	14	10000	11	13000
1-2	7	6000	4	9000
2-3	9	11000	6	18000
3-4	4	9000	3	12000

	4-5	3	6000	2	7800		
10.	Explain in detail about resource oriented scheduling?					BT 3	Applying
11.	A project of five activities, whose activity relationships, activity durations (normal and crash) and activity costs (normal and crash) are given in the following table. Estimate the optimum cost and time. Indirect cost is Rs80/ per day.					BT 3	Applying
	ACTIVITY	**NORMAL**		**CRASH**			
		TIME (WEEKS)	**COST(Rs)**	**TIME (WEEKS)**	**COST(Rs)**		
	10-20	3	12000	2	16000		
	10-30	6	18000	3	24000		
	20-40	2	20000	1	23000		
	30-40	4	16000	2	21000		
	40-50	5	30000	4	35000		
12.	Discuss about the various methods of presenting project schedules.					BT 3	Applying
13.	i) Discuss about direct cost and indirect cost? (7) ii) What are the constraints of scheduling? Explain how each constraint affects scheduling? (6)					BT 4	Analyzing
14.	Describe the techniques used for scheduling a project with uncertain duration? Explain any one of them in detail?					BT 5	Evaluating
15.	Explain critical path method with neat sketch.					BT 3	Applying
16.	Explain activity float and schedule.					BT 4	Analyzing
17.	Explain the factors affecting Resource scheduling.					BT 4	Analyzing
	PART C						
1.	Define crashing of activities, rules for crashing and draw the corresponding graphs and explain direct cost, indirect cost(overhead cost), crashing cost and total cost.					BT 5	Evaluating
2.	The following table shows the activity needed to compute the project with their normal time and the shortest time in which the activity can be completed for a building contract and the cost per day for reducing the time of each activity. The contract includes a penalty clause of Rs.100 per day over 17 days. The overhead cost per day is Rs.160					BT 4	Analyzing

ACTIVITY	NORMAL TIME (DAYS)	SHORTEST TIME (DAYS)	COST REDUCTION PER DAY
1-2	6	4	80
1-3	8	4	90
1-4	5	3	30
2-4	3	3	-
2-5	5	3	40
3-6	12	8	200
4-6	8	5	50
5-6	6	6	-

i. Cost completing the 8 activities in normal time is Rs.6500. Estimate the normal duration of the project, its cost and its critical path

ii. Estimate the optimum duration of the project and their corresponding cost using cost time function.

3.	The details of a network are given below where the duration is in days.	BT 4	Analyzing

ACTIVITY	t_0	t_m	t_p
1-2	2	5	8
1-3	1	4	7
2-3	0	0	0
2-4	2	4	6
2-6	5	7	12
3-4	3	5	10
3-5	3	6	9
4-5	7	6	10
4-6	2	5	8
5-6	2	4	6

Describe the critical path, float and project completion time?

4.	Prepare a CPM network from the list of operations and time for each operation. Prepare a table giving ES, EF, LS, LF times and total float for each operation. Mark on the diagram the critical path and also the minimum time required for the completion the project.	BT 5	Evaluating

Activity	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O
Duration weeks	3	5	4	7	6	11	6	4	3	6	5	7	5	3	2
Preceed	-	A	A	B	B	C	D	E,F	C	G	H,I	I	H,I	K	L
Success	B,C	D,E	F,I	G	H	H	I	K	K,L	M	N	O	N	-	-

5.	The detail of a network are given below where duration are in days. Find the critical path project completion time and all floats.	BT 5	Evaluating

Activity	A	B	C	D	E	F	G
Predecessor	-	-	A,B	C	C	D	D,E
Duration	3	5	4	6	3	2	4

UNIT III - COST CONTROL MONITORING AND ACCOUNTING

The cost control problem-The project Budget-Forecasting for Activity cost control - financial accounting systems and cost accounts-Control of project cash flows-Schedule control-Schedule and Budget updates-Relating cost and schedule information.

PART – A

Q.NO	QUESTIONS	BT LEVEL	COMPETENCE
1.	What is meant by contingencies and define income?	BT 1	Remembering
2.	What are the project cost budget monitoring parameters?	BT 1	Remembering
3.	List out the sources of cash inflow and cash outflow.	BT 1	Remembering
4.	Differentiate financial and managerial accounting.	BT 1	Remembering
5.	Explain the term project budget.	BT 1	Remembering
6.	List out the classification of cost control.	BT 1	Remembering
7.	Write down the advantages of financial accounting.	BT 2	Understanding
8.	Explain the objectives of cost accounting and necessity for project management.	BT 2	Understanding
9.	Differentiate between fixed cost and variable cost.	BT 2	Understanding
10.	Classify the types of accounting system.	BT 2	Understanding
11.	Compare cost committed from cost exposure.	BT 1	Remembering
12.	Explain schedule control.	BT 1	Remembering
13.	Name the controls considered before start of the projects.	BT 2	Applying
14.	Define project cash flow.	BT 1	Remembering
15.	Compare percentage completion method and completed contract method	BT 1	Remembering

16.	Distinguish between budget cost and revised cost.	BT 1	Remembering
17.	Create the S-curve and mention its uses.	BT 1	Remembering
18.	List out the components of cash flow status report.	BT 1	Remembering
19.	Rewrite the formula for schedule control.	BT 1	Remembering
20.	Discuss about the account payable journal and accounts receivable journal.	BT 2	Understanding
21.	Define cost accounting.	BT 1	Remembering
22.	Define cost ratio.	BT 2	Understanding
23.	What are the different compounds of a balance sheet?	BT 2	Understanding
24.	List out any five indirect cost.	BT 2	Understanding
	PART – B		
1.	i. Describe the stages of work at which cost control is affected. (7) ii. Classify the cost control systems and explain it. (6)	BT 4	Analyzing
2.	Brief about the project budget?	BT 4	Analyzing
3.	Explain in detail about the cash flow control in a project.	BT 3	Applying
4.	List out the various categories of cost involved in a project. Explain it in detail.	BT 4	Analyzing
5.	Describe about on Schedule control.	BT 3	Applying
6.	Explain the elements of cash flow status report.	BT 4	Analyzing
7.	Illustrate the main points in determination of cash flow.	BT 4	Analyzing
8.	Suppose that a company began six jobs in a year, completing three jobs and having three jobs still underway at the end of the year. Details of the six jobs are shown in the table given below. Evaluate the company's net profit.	BT 3	Applying

Net Profit on Completed Contracts (amounts in thousands)	
Job 1	1436
Job 2	356
Job 3	-738
Total Net Profit on Completed Jobs	1054

	Status of Jobs underway	Job 4	Job 5	Job 6		
	Original control price	4200	3800	5630		
	Contract changes (change orders)	400	600	-300		
	Total cost to date	3600	1710	620		
	Payments received or due to date	3520	1830	340		
	Estimated cost to complete	500	2300	5000		
9.	Describe the Forecasting for activity cost control.				BT 3	Applying
10.	How will you calculate the net profit using percentage of completion method and completed contract method				BT 4	Analyzing
11.	Define budget and describe its importance for a construction project and explain how the cost and time trends monitored using S curve.				BT 3	Applying
12.	Write a brief note on relating cost and schedule information.				BT 4	Analyzing
13.	Explain the terms, i. Measurement of cost performance (7) ii. Investment appraisal (6)				BT 4	Analyzing
14.	Give a detailed explanation on schedule and budget updates. Describe the following, i. Control estimate (7) ii. Cost planning (6)				BT 3	Applying
15.	Explain the types of Accounting systems in detail.				BT 4	Analyzing
16.	Explain the different stages of cost control in detail.				BT 3	Applying
17.	What are the major causes of unfavorable direct cost variances? Explain the two major objectives of budgeted cost analysis.				BT 4	Analyzing
	PART – C					
1.	Fill the table below. It lists 8 different financial transactions for a construction project. Classify them as Direct cost, Indirect cost, Overhead cost, Cash inflow and outflow.				BT 4	Analyzing

S.No	**Financial component**	**Cash inflow, outflow**	**Direct cost , Indirect cost, Overhead cost**
1.	Mobilization advance given by client		
2.	Expenditure for worker		

		accident treatment				
	3.	Raw materials purchase				
	4.	Payment for advertisement				
	5.	Monthly salaries and wages				
	6.	Hire charges for machineries				
	7.	Deposit paid to client while getting the work				
	8.	Constructing the temporary office at site				
2.	Explain the different components of accounting system and methods of accounting.				BT 4	Analyzing
3.	Discuss how the cost control for a construction project is carried out.				BT 4	Analyzing
4.	Describe the cash flow statement for a contractor company for residential project showing the various inflow and outflow components for 6 months duration.				BT 5	Evaluating
5.	What are the guide lines to be kept in mind while preparing a budget to make it more effective?				BT 5	Evaluating

UNIT IV - QUALITY CONTROL AND SAFETY DURING CONSTRUCTION

Quality and safety Concerns in Construction-Organizing for Quality and Safety-Work and Material Specifications-Total Quality control-Quality control by statistical methods - Statistical Quality control with Sampling by Attributes-Statistical Quality control with Sampling by Variables Safety.

PART – A

Q.NO	QUESTIONS	BT LEVEL	COMPETENCE
1.	Define quality circle	BT 1	Remembering
2.	List the important items to be inspected during the construction	BT 1	Remembering
3.	List out the safety measures	BT 1	Remembering
4.	Define accident	BT 1	Remembering
5.	List the applications of quality circle	BT 1	Remembering
6.	Define injury frequency rate	BT 1	Remembering
7.	Distinguish the health and safety	BT 2	Understanding
8.	How will you interpret the quality control when chance cause and assignable cause exists in a process??	BT 2	Understanding
9.	Discuss the various causes of accident	BT 2	Understanding
10.	Summarize the sampling by attributes	BT 2	Understanding
11.	Classify the statistical sampling methods for quality control	BT 2	Understanding

12.	Examine how the quality control is important in a construction project	BT 2	Understanding
13.	Show the various charts used in statistical quality control	BT 2	Understanding
14.	Explain producer's risk and consumer's risk	BT 2	Understanding
15.	Explain the total quality control	BT 2	Understanding
16.	Differentiate sampling by attributes and sampling by variables	BT 2	Understanding
17.	Prepare a list of duties of quality circle?	BT 1	Remembering
18.	How will you prepare yourselves for the safety audit?	BT 1	Remembering
19.	What are the charts would you recommend for statistical quality control?	BT 2	Understanding
20.	How do you assess the injury frequency rate?	BT 1	Remembering
21.	Define quality circle.	BT 2	Understanding
22.	Define variable	BT 1	Remembering
23.	How do you improve in jobsite in construction?	BT 2	Understanding
24.	Mention two safety quotation.	BT 2	Understanding
	PART – B		
1.	Describe the statistical quality control with sampling by attributes.	BT 4	Analyzing
2.	Describe the total quality management and collect the details about the statistical quality control with sampling by variables.	BT 3	Applying
3.	Define accidents and the causes for accidents at construction sites and the various costs are associated with accidents.	BT 3	Applying
4.	Discuss the importance of quality and safety in construction.	BT 4	Analyzing
5.	Summarize the safety requirements of construction industry.	BT 3	Applying
6.	Classify the different methods of statistical quality control.	BT 3	Applying
7.	Explain the problems associated with the safety of a construction site.	BT 4	Analyzing
8.	Explain the importance of safety.	BT 4	Analyzing
9.	Prepare a list of human factors which causes an accidents and mention the various causes of accident.	BT 4	Analyzing

10.	Summarize the following: (i) Statistical quality control by sampling (7) (ii) Safety in construction (6)	BT 3	Applying
11.	Define and differentiate between QA and QC with example.	BT 3	Applying
12.	List the safety precautions for the high rise RCC cast-in-situ construction.	BT 3	Applying
13.	Define and differentiate between statistical quality control with sampling of attributes and statistical quality control with sampling of variables	BT 4	Analyzing
14.	Give detail about the measurement of safety.	BT 5	Evaluating
15.	Explain the various stages of risk cost management.	BT 3	Applying
16.	Briefly explain about the concept of Total quality control and describe how it is established in construction industry.	BT 4	Analyzing
17.	Explain the Statistical Quality control with Sampling by Variables Safety	BT 4	Analyzing
	PART C		
1.	Discuss about the accident prevention programme and provide the general safety programme for a construction project	BT 5	Evaluating
2.	Describe the quality assurance techniques.	BT 4	Analyzing
3.	"Indian construction industry requires a comprehensive legislation for the quality, safety and welfare of its workman" Analyse the above statement and comment on it.	BT 4	Analyzing
4.	Create a brief report on residential project for quality analysis and safety elements which is carried out on the site.	BT 5	Evaluating
5.	Write the case study about historical review of Quality control.	BT 5	Evaluating
	UNIT V - ORGANIZATION AND USE OF PROJECT INFORMATION		
	Types of project information-Accuracy and Use of Information-Computerized organization and use of Information -Organizing information in databases-relational model of Data bases-Other conceptual Models of Databases-Centralized database Management systems-Databases and application programs-Information transfer and Flow.		
	PART – A		
Q.NO	**QUESTIONS**	**BT LEVEL**	**COMPETENCE**
1.	Name the PIMS components	BT 1	Remembering
2.	List the types of project information in respect of a construction project.	BT 1	Remembering

3.	Define relational database	BT 1	Remembering
4.	List out the information set for the progress of the project	BT 1	Remembering
5.	List out the advantages and disadvantages of centralized database management system	BT 1	Remembering
6.	Define decision support system	BT 1	Remembering
7.	Discuss the different stages in construction	BT 2	Understanding
8.	Summarize a few lines about the PIMS	BT 2	Understanding
9.	Describe the database management program	BT 2	Understanding
10.	Estimate how the centralized DBM is more advantages over stand-alone system.	BT 2	Understanding
11.	Examine the performance specifications	BT 1	Remembering
12.	Examine how the accuracy is necessary in information	BT 1	Remembering
13.	Show the importance of network code specifications	BT 2	Applying
14.	Explain the integrated system design	BT 1	Remembering
15.	How will you analyze the network data model?	BT 1	Remembering
16.	Compare the organized information and unorganized information	BT 1	Remembering
17.	Prepare a list of other conceptual models of databases	BT 1	Remembering
18.	How will you generalize the information transfer and flow	BT 1	Remembering
19.	Why do you recommend the object oriented data representation?	BT 1	Remembering
20.	Compare the relational model of data bases and conceptual models of databases	BT 1	Remembering
21.	What are the types of project information?	BT 1	Remembering
22.	Define DBM	BT 2	Understanding
23.	What are the advantages of relational models of databases?	BT 2	Understanding
24.	Define hierarchical model	BT 2	Understanding
	PART – B		
1.	Describe the database management system.	BT 4	Analyzing
2.	Elaborate in detail about the various sets of information collected in regard to construction project information.	BT 4	Analyzing

3.	List out the various functions of different managers and the software required for their requirements.	BT 3	Applying
4.	Discuss in detail about the computerized organization and use of information in a project.	BT 4	Analyzing
5.	How will you interpret the database approach to contractor's account and explain it briefly? Mention its advantages and disadvantages also.	BT 3	Applying
6.	Briefly explain the hierarchical models for organizing databases.	BT 4	Analyzing
7.	Illustrate a typical flow chart of an integrated accounting system for the generation of financial reports and explain them briefly.	BT 4	Analyzing
8.	Explain the information transfer and flow in organizing project information.	BT 3	Applying
9.	Describe the network models for organizing project information databases.	BT 5	Evaluating
10.	Bring out the benefits of computerized information system.	BT 4	Analyzing
11.	Describe the importance of information system in the	BT 3	Applying
	effective management of construction.		
12.	Explain the any two types of DBMS based on Information Systems followed in construction industry	BT 4	Analyzing
13.	Discuss in detail about various quality control by statistical methods.	BT 4	Analyzing
14.	Explain the main functions of Project Management Information System? What are the major components of it?	BT 3	Applying
15.	Explain how the information can be organized using computers.	BT 4	Analyzing
16.	Explain centralized database management system.	BT 3	Applying
17.	Explain the problems in information system management in detail.	BT 4	Analyzing
PART – C			

1.	Design an organization chart for the medium size construction company and explain it briefly.	BT 4	Analyzing
2.	Discuss the problems in information system management.	BT 4	Analyzing
3.	Explain how you will assess the information in an organized manner using computers.	BT 4	Analyzing
4.	Illustrate a frame based data storage hierarchy system adopted in construction industry.	BT 5	Evaluating
5.	Explain the types of project information? Write the use of project information in construction.	BT 5	Evaluating