Guided Exercises / Practical Work 2

Today's effort becomes tomorrow's wisdom

Exercise 1: E-Commerce Platform Development

Your team is building a full-stack e-commerce platform with product catalog, shopping cart, payment gateway, and admin dashboard.

Project Activities

ID	Activity	Duration (Days)	Predecessor(s)
A	Market Research & Requirements	5	—
B	System Architecture Design	4	A
C	Database Schema Design	3	B
D	Product Catalog Module	6	C
E	User Authentication Module	4	C
F	Shopping Cart & Checkout	7	D, E
G	Payment Gateway Integration	5	F
H	Admin Dashboard	4	D
I	System Integration & API Testing	4	G, H
J	User Acceptance Testing (UAT)	3	I
K	Production Deployment	2	J

Questions

Part 1 – *A.* Network Diagram

(a) Draw the PERT network diagram (activity-on-node format).

(b) List all possible paths from start to finish.

(c) Identify the longest path visually.

Part 2 – *B.* Time Analysis

(a) Calculate ES (Earliest Start) and EF (Earliest Finish) for each activity.

(b) Calculate LS (Latest Start) and LF (Latest Finish) for each activity.

(c) Compute Slack Time ($Slack = LS - ES$) for each activity.

Part 3 – *C.* Critical Path

(a) Identify the critical path(s).

(b) What is the minimum project duration?

(c) Which activities have zero slack?

Part 4 – *D.* Risk Analysis

(a) If activity **F** (Shopping Cart) is delayed by 3 days, does the project finish date change? Justify.

(b) If activity **H** (Admin Dashboard) finishes 2 days early, can the project finish earlier? Why or why not?

(c) Why is slack time important for project managers when allocating resources?

Bonus Challenge (Advanced)

Assume three-time estimates for each activity. Using the PERT formula:

$$T_E = \frac{O + 4M + P}{6}$$

Calculate expected durations and variance ($\sigma^2 = \left(\frac{P-O}{6}\right)^2$). Then:

- Recalculate the critical path using T_E
- Compute the probability that the project finishes within 35 days (use normal distribution approximation)

Exercise 2: AI-Powered Recommendation Engine

Context: Your startup is developing a machine learning recommendation system for a streaming platform (movies/music).

Project Activities

ID	Activity	Duration (Days)	Predecessor(s)
A	Data Collection & Cleaning	6	—
B	Feature Engineering	5	A
C	Model Selection & Prototyping	4	B
D	Training Pipeline Development	7	C
E	Evaluation Framework	3	C
F	A/B Testing Infrastructure	5	D, E
G	Real-time API Development	6	D
H	Dashboard for Analytics	4	E
I	Model Deployment & Monitoring	3	F, G, H
J	Performance Optimization	4	I

Questions

Part 1 – *A.* Network Analysis

(a) Draw the PERT diagram.

(b) How many merge points (nodes with multiple incoming arrows) exist? Why are they risky?

Part 2 – *B.* Forward & Backward Pass

(a) Perform forward pass to compute ES/EF.

(b) Perform backward pass to compute LS/LF.

(c) Tabulate all values in a single table.

Part 3 – *C.* Critical Path & Float

(a) Identify critical path(s).

(b) Which activity has the largest slack? What does this mean for scheduling flexibility?

(c) If two critical activities run in parallel, how does this affect risk management?

Part 4 – *D.* Agile Considerations

(a) In Agile development, would you still use PERT? Justify your answer.

(b) How would you adapt this PERT analysis for 2-week sprints?

Bonus Challenge (Advanced)

Introduce resource constraints: only 2 ML engineers available. Activities D, E, G require 1 engineer each; F requires 2 engineers simultaneously.

- Identify resource conflicts on the critical path
- Propose a feasible schedule respecting constraints (without changing dependencies)

Exercise 3: IoT Smart Home System

Context: Your team is developing an IoT platform connecting sensors (temperature, motion, cameras) to a central hub with mobile app control.

Project Activities

ID	Activity	Duration (Days)	Predecessor(s)
A	Hardware Specification	4	—
B	Sensor Firmware Development	8	A
C	Hub Firmware Development	7	A
D	Cloud Backend Architecture	5	A
E	Device-to-Cloud Protocol	6	B, C, D
F	Mobile App UI Design	4	D
G	Mobile App Development	9	E, F
H	Security & Encryption Layer	5	E
I	End-to-End Integration Testing	6	G, H
J	Beta Testing with Users	5	I
K	Certification & Compliance	7	J
L	Mass Production Setup	4	K

Questions

Part 1 – *A.* Complex Dependencies

(a) Draw the PERT diagram (note: activity E has **three** predecessors).

(b) Identify all paths and their total durations.

Part 2 – *B.* Time Calculations

(a) Compute ES, EF, LS, LF for all activities.

(b) Create a table showing Duration, ES, EF, LS, LF, and Slack for each activity.

Part 3 – *C.* Critical Path Analysis

(a) What is the critical path? Highlight it in red on your diagram.

(b) What is the total project duration?

(c) If activity **H** (Security) is delayed by 4 days, what happens to the project end date?

Part 4 – *D.* Hardware-Software Co-design

(a) Why is activity E (Protocol) a high-risk bottleneck?

(b) How would you mitigate risk for activities with multiple predecessors?

(c) In embedded systems projects, why is the critical path often dominated by hardware dependencies?

Bonus Challenge (Advanced)

Assume optimistic/pessimistic estimates. After computing T_E:

- Calculate the standard deviation of the critical path
- Determine the project duration with 95% confidence level ($Z = 1.645$)

Exercise 4: Cross-Platform Mobile Health App

Context: Your team is building a health tracking app (iOS/Android) with wearable integration, data visualization, and telemedicine features.

Project Activities

ID	Activity	Duration (Days)	Predecessor(s)
A	Regulatory Requirements Analysis	5	—
B	UX/UI Wireframing	4	A
C	iOS Development	10	B
D	Android Development	10	B
E	Wearable API Integration	6	C, D
F	Backend Microservices	8	A
G	Data Visualization Engine	5	F
H	Telemedicine Module	7	F
I	HIPAA Compliance Implementation	6	E, G, H
J	Clinical Validation Testing	8	I
K	App Store Submission & Review	5	J

Questions

Part 1 – *A.* Parallel Development

(a) Draw the PERT diagram. Note the parallel iOS/Android tracks.

(b) How does parallel development affect the critical path?

Part 2 – *B.* Time Analysis

(a) Compute ES/EF using forward pass.

(b) Compute LS/LF using backward pass.

(c) Identify activities with positive slack.

Part 3 – *C.* Critical Path & Sensitivity

(a) What is the critical path? Is it unique?

(b) If iOS development (C) finishes 2 days early but Android (D) is delayed by 3 days, what is the net impact?

(c) Why might regulatory activities (A, I) be critical even with moderate duration?

Part 4 – *D.* Real-World Constraints

(a) App Store review (K) has variable duration (310 days). How would you model this uncertainty?

(b) Why is clinical validation (J) often a project bottleneck in health tech?

(c) Propose 2 strategies to compress the project schedule without adding resources.

Bonus Challenge (Advanced)

Crashing Analysis: Management demands 5-day schedule compression. Given crash costs:

Activity	Crash Cost ($/day)
C/D (Mobile Dev)	$800
F (Backend)	$600
J (Validation)	$1,200
K (Submission)	Not crashable

- Which activities should be crashed to minimize cost?
- What is the minimum cost to achieve 5-day compression?