Systems Engineering and Project Management

Exam Preparation Notes (Simple)

Compiled from merged Anki decks

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Contents

Q2: What is a system?

Answer

A system is a set of parts that work together. It includes people, products, and processes to achieve a goal.

Q3: What are common characteristics of systems?

Answer

- Structure (parts)
- Behavior (what it does)
- Interconnections (how parts interact)

Q4: What is a system according to IEEE Std 1220-1998?

Answer

A set of related elements and processes that satisfies customer/operational needs and supports the product over its life cycle.

Q5: What is a system according to ISO/IEC 15288:2008?

Answer

A combination of interacting elements organized to achieve one or more purposes.

Q6: What do systems have?

Answer

- Limits (physical limits, timing limits)
- An environment that affects them

Q7: How can systems be described?

Answer

- Structure (what it consists of)
- Functionality (what it does)
- Purpose (why it exists)

Q8: What is engineering?

Answer

Engineering applies scientific and practical knowledge to design, build, and improve things (machines, tools, systems, processes).

Q9: What is systems engineering?

Answer

Systems engineering designs and manages complex systems over their whole life cycle.

Q10: Which areas/disciplines are related to systems engineering?

Answer

- Requirements engineering
- Reliability engineering
- Logistics
- Control engineering
- Software engineering
- Project management

Q11: What are the three most important tasks of systems engineering?

Answer

- Use models/simulations to evaluate and validate early.
- Find errors early using safety methods.
- Decide early to avoid expensive consequences later.

Q12: List the two different types of models used in simulation.

Answer

- Multi-domain model
- Hierarchical model

Q13: What is the main objective of safety engineering?

Answer

Make the system safe (acceptable risk, safe behavior in operation).

Q14: How is risk defined?

Answer

Risk = probability $\times$ consequence.

$$r(e) = p(e) \cdot c(e)$$

- $p(e)$ = probability the event happens
- $c(e)$ = damage/cost (e.g., EUR/USD)

Q15: What are the two techniques introduced in the lecture for risk assessment?

Answer

- FMEA = Failure Mode and Effects Analysis
- FTA = Fault Tree Analysis

Q16: What are consequences of poorly designed systems?

Answer

- Financial losses
- Injuries or death
- Reputation / PR damage

Q17: What are the foundational ideas behind SYSMOD?

Answer

Start with a black box, then refine.

- Identify elements
- Describe the context (what interacts with the system)
- Build the inside view step by step

Q18: In SYSMOD, what are the different roles of systems engineers?

Answer

- Systems engineer:
  - Requirements analyst: collects and manages requirements
  - System architect: creates the architecture from requirements
- Project administrator
- System tester

Q19: What are the 6 tasks of SYSMOD?

Answer

1. Define system idea and goals
2. Define basic architecture
3. Define requirements
4. Model system context
5. Model use cases

6. Model expertise/knowledge

Do it iteratively (repeat and improve).

Q20: What is a project notebook (Projekttagebuch)?

Answer

A diary of the project: notes collected during the whole project.

Q21: Difference between a project notebook and a meeting protocol?

Answer

- Project notebook: notes for the whole project (includes meetings too).
- Meeting protocol: notes for one meeting only.

Q22: What must be in a meeting protocol?

Answer

- Title
- Date and place
- Participants
- Summary of discussion
- Decisions / actions

Q23: What is always the reason for starting systems engineering?

Answer

A system idea / need (we want to build something to solve a problem).

Q24: What should requirements never describe?

Answer

Never describe the solution. Requirements say **what**, not **how**.

Q25: Requirement vs. solution?

Answer

- Requirement: what the system must do/have
- Solution: how it is implemented

Q26: Questions to clarify system ideas and objectives?

Answer

- Can you explain the system in 5 minutes?
- What are the top 3 goals?
- Does everyone know the goals?
- What is out of scope (goals not pursued)?

Q27: Subgoals of requirements engineering in SYSMOD?

Answer

- Identify stakeholders
- Document requirements

Q28: Why are stakeholders important?

Answer

Stakeholders define what the system must do. They are the source of requirements.

Q29: What is system context and why important?

Answer

System context = system boundary + external actors/interfaces. It shows how the system interacts with its environment.

Q30: What is a use case?

Answer

A use case describes how an actor uses the system to reach a goal.

Q31: Which SysML diagram describes system structure?

Answer

Block Definition Diagram (BDD).

Q32: Why are state diagrams important in SYSMOD?

Answer

They show system behavior: states and transitions (what happens in different situations).

Q33: What are the objectives of UML?

Answer

- Model a system with diagrams
- Show different views (structure + behavior)
- Reduce complexity (decompose and refine)
- Support communication (customer + developers)
- Use standard notation

Q34: Must we use all UML diagram types?

Answer

No. Use only diagrams that help. Often enough: use case + class diagram.

Q35: What is an object in UML?

Answer

An object is an instance of a class. It has state and behavior.

Q36: Properties of a UML object?

Answer

- Data + behavior together
- Encapsulation (data hiding)
- Unique identity
- Attributes store state

Q37: What is encapsulation?

Answer

State is inside the object (attributes). You change it only via methods.

Q38: What is a class in UML?

Answer

A class is a template for objects. It defines attributes, operations, and relationships.

Q39: What are relationships in UML?

Answer

Connections between model elements, e.g.:

- Dependency: changes in one affect another

- Instantiation: create an object from a class

Q40: What are associations in UML?

Answer

An association is a connection between classes (a line). It can have name, role names, multiplicity, navigability.

Q41: Explain the UML object diagram (club/person example).

Answer

- DownhillSkiClub is an object of class `Club`.
- Jim is an object of class `Person`.
- They are linked by an association (role: "chairman").

Q42: What information do associations have?

Answer

Name, role names, multiplicity, navigability.

Q43: Explain the Company–Person class diagram. Why not enough for finance/social security?

Answer

- `Company` and `Person` are classes.
- `employs` is the association.
- Roles: employer / employee.

Not enough for finance/social security because important details are missing (salary, job type, tax data, time periods, etc.).

Q44: What is inheritance? Principles?

Answer

Inheritance builds a hierarchy. A subclass inherits attributes and methods from a superclass. Methods can be overridden.

Example: `Cat` inherits from `Animal`.

Q45: Square vs. Rectangle inheritance (which direction is correct)?

Answer

If you model it with inheritance: `Square` as a special case of `Rectangle`. Be careful: rectangle setters (e.g., `setHeight`) can break the square rule (all sides equal).

Q46: What is polymorphism?

Answer

Same interface, different behavior. The same method call can work differently depending on the object's class.

Q47: What is a component in UML?

Answer

A component is a replaceable system part. It packages implementation and provides interfaces. It is a reuse unit.

Q48: Purpose of a UML deployment diagram?

Answer

It shows hardware nodes and where software runs on them.

Q49: What are UML use cases and what do they describe?

Answer

Use cases describe user goals and interactions. They capture functional requirements.

Q50: Which UML diagram type is the figure?

Answer

Activity diagram.

Q51: What does the diagram describe and which UML diagram type is it?

Answer

State diagram (with call events). Example: bank account states and actions (deposit/withdraw/overdraw).

Q52: Name at least 4 structural UML diagrams.

Answer

- Class diagram
- Object diagram
- Component diagram
- Deployment diagram
- Package diagram

Q53: Name at least 4 behavioral UML diagrams.

Answer

- Use case diagram
- Activity diagram
- State machine diagram
- Sequence diagram
- Communication diagram

Q54: What is SysML?

Answer

SysML is a modeling language for systems engineering. It is based on UML, but extended for SE.

Q55: UML vs. SysML differences?

Answer

SysML adds SE concepts like: blocks, requirements, allocations, parametrics, item flows.

Q56: BDD vs. IBD in SysML?

Answer

- BDD: defines blocks (types) and their properties.
- IBD: shows internal parts and connections (inside one block).

Q57: What are parametric diagrams in SysML?

Answer

They show equations/constraints between value properties. Used for engineering analysis.

Q58: Explain the parametric diagram content (vehicle dynamics).

Answer

Several equations are connected. Outputs of one equation feed into others. Inputs can be time, mass, friction, etc. Together they model vehicle motion on a straight line.

Q59: What are requirements diagrams in SysML?

Answer

They model requirements and links between them (e.g., refine, satisfy, verify, trace). A `<<requirement>>` box is a text requirement.

Q60: Are requirements diagrams part of UML?

Answer

No.

Q61: What is a requirement and what should be avoided?

Answer

A requirement states what the system must do/have. Avoid writing the solution (avoid "how").

Q62: Explain the HSUV requirement diagram.

Answer

HSUV has two main requirement groups: Eco-Friendliness and Performance. They are broken down into smaller requirements (e.g., Emissions, Braking, Fuel Economy, Acceleration). Links show refine/verify/satisfy relations.

Q63: What characterizes a project?

Answer

A project is unique. It has start and end dates. It uses limited resources. It has a goal. It has complexity.

Q64: What is a project?

Answer

A project is a complex task with a clear goal and a defined time frame. It needs a project-specific organization.

Q65: What is a project-specific organization?

Answer

- Project manager/admin
- Project team
- Project plan (tasks, resources, dates)
- Steering / control (stakeholders, steering committee)

Q66: Tasks of the project leader?

Answer

- Communicate
- Delegate
- Plan work and resources

- Motivate the team
- Control progress

Q67: Why is project management and planning necessary?

Answer

Without management, projects fail more often. PM makes complexity controllable. The plan is a control tool and helps motivation.

Q68: Phases of a project?

Answer

1. Identify activities
2. Decide to start and organize the project
3. Kick-off
4. Plan and execute
5. Conclude the project

Q69: Purpose of a project plan? What must be included?

Answer

A project plan estimates effort and cost. It schedules tasks and resources. It must be updated during the project.

Q70: Methods for cost/effort estimation?

Answer

- Individual estimation (expert estimate)
- Group estimation
- Methods: function points, use-case points, COCOMO II

Q71: What is the Cone of Uncertainty?

Answer

Uncertainty is high at the beginning. It decreases over time. At the end it is low.

Q72: Steps of project planning?

Answer

1. Identify activities
2. Plan dependencies
3. Estimate effort

4. Plan resources
5. Plan costs
6. Assess risks and consequences

Q73: Forward/backward calculation for dates (critical path idea).

Answer

Do forward pass (earliest times) and backward pass (latest times). The longest path is the critical path. Delay on it delays the whole project.

Q74: What are milestones?

Answer

Milestones are important events. They should be defined explicitly (e.g., phase end, acceptance).

Q75: What are critical paths?

Answer

The critical path is the longest path in the plan. If it delays, the project delays.