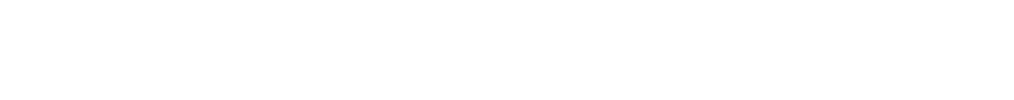


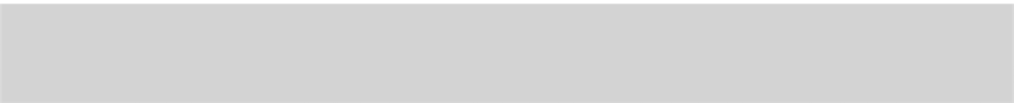
**FRAGE 1 VON 91**

**DLMDSINDA01\_Offen\_leicht/Lektion 01**



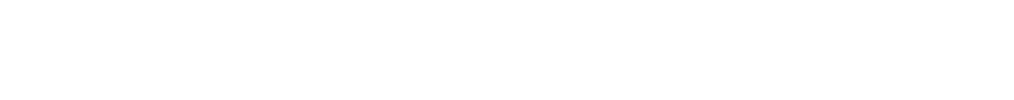
Define industrial automation.

Industrial automation is the use of tecnnologies and automatic devices **(3 points)** to control machines, systems, and processes **(3 points)**.



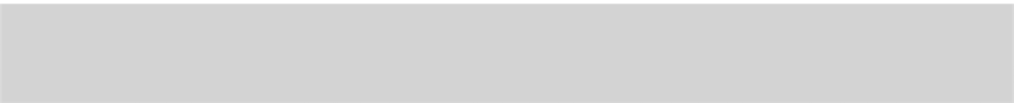
**FRAGE 2 VON 91**

**DLMDSINDA01\_Offen\_leicht/Lektion 01**



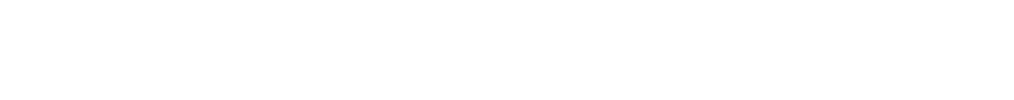
Describe the goal of programmable automation.

Programmable automation aims at producing a large variety of products **(3 points)** with a minimal capital expense to purchase additional machines **(3 points)**.



**FRAGE 3 VON 91**

**DLMDSINDA01\_Offen\_mittel/Lektion 01**



Describe the goal of flexible automation.

Flexible automation enables organizations to change over configurations **(3 points)** to produce new products with no downtime due to off-line configuration of the machine **(3 points)**.



**FRAGE 4 VON 91**

**DLMDSINDA01\_Offen\_mittel/Lektion 01**



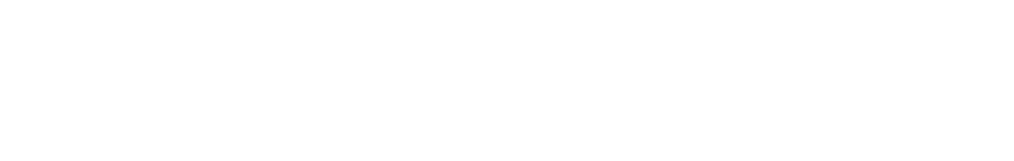
Name and describe briefly the level 0 of the automation pyramid.

The level 0 (production process) includes so-called field-level devices, which are controllers, sensors, actuators and motors used to run machinery **(3 points)**. These devices ensure the safety of operations and guarantee the required specifications of the products **(3 points)**.



**FRAGE 5 VON 91**

**DLMDSINDA01\_Offen\_schwer\_F1/Lektion 01**



Explain the level 3 of the automation pyramid in detail, focusing on the role of Manufacturing Execution Systems.

Finally, name three benefits of MES systems.

The level 3 (Manufacturing operations management) aims at monitoring and planning products via a Manufacturing Execution System (MES), **(3 points)**.

MES allows organizations to make real-time decisions withing the production based on the information received by previous levels (e.g., SCADA and PLCs) **(3 points)**. In the MES, organizations process data coming from devices to calculate performance indicators (e.g., **OEE**, ) and to regulate process control systems **(3 points)**.

The benefits of a MES system are: elimination of waste

reduction of paperwork

standardization of operational processes

acceleration of diagnosis for product and process issues increased control over processes

# (3 points for each benefit, max 9 points) .



**FRAGE 6 VON 91**

**DLMDSINDA01\_Offen\_schwer\_F1/Lektion 01**



Explain the idea and vision behind "industry 4.0". Name the four main goals.

In 2011 the German government created a project called “Industrie 4.0”—also known as Industry 4.0—to promote the integration of technology, in particular IT, within manufacturing **(3 points)**. In an effort to move out of the traditional automation age of Industry 3.0, it was the vision of the German government to create what some called a “smart factory” that would include **cyber- physical systems, cloud computing,** and the **IIoT (1 point per Concept)**, resulting in

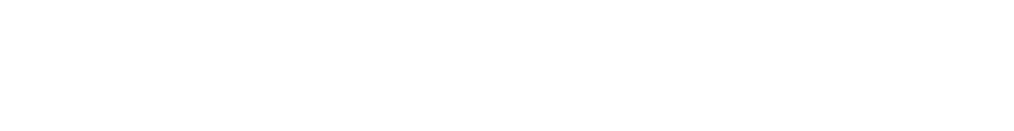
interoperability, **(3 points)**

the decentralization of information, **(3 points)** real-time data collection, and **(3 points)** increased flexibility **(3 points)**



**FRAGE 7 VON 91**

**DLMDSINDA01\_Offen\_leicht/Lektion 02**



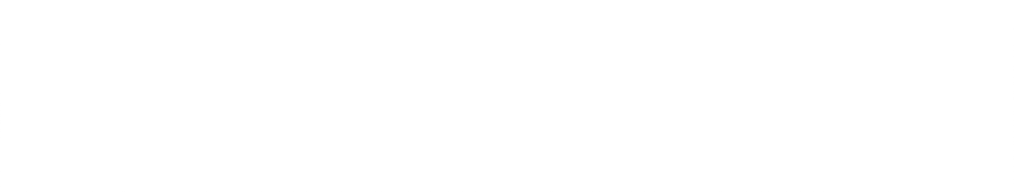
Describe the properties of **non-deterministic** finite automata compared to deterministic ones.

For non-deterministic finite automata there is no unique successive state from a previous one at a certain input **(3 points).** Furthermore, the so-called empty word ε is a legal input to change between states **(3 points)**



**FRAGE 8 VON 91**

**DLMDSINDA01\_Offen\_leicht/Lektion 02**



Name a method for the transfomation of a **non-deterministic** to a deterministic finite automaton.

Of how many states can a deterministic finite automaton consist as the result of the transformation? Name and briefly describe.

|K|

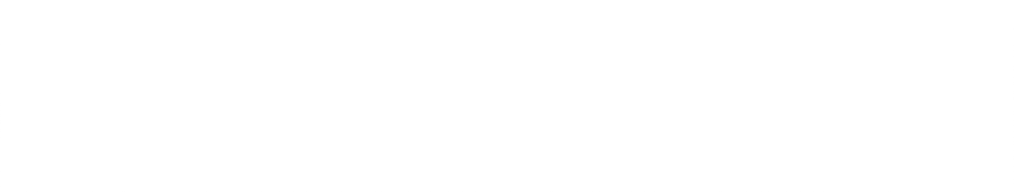
powerset construction **(3 points)**. Tt can consist of 2 states, where K is the set of states of the

non-deterministic automation **(3 points)**.



**FRAGE 9 VON 91**

**DLMDSINDA01\_Offen\_mittel/Lektion 02**



1. Define a regular expression that accepts the words abc, aba, abaaa, abcca.
2. Define a second regular expression that accepts the words aabc, ababc, bbbbc and baaabc.

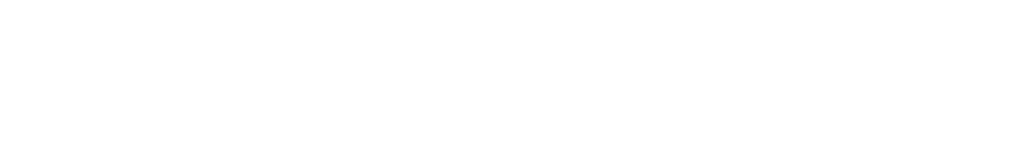
# R=ab(c|a)\* (1 points for a, 1 points for b and one point for (c|a)\*) (other solutions possible)

1. R=(a|b)\*c **(1 points for (a|b), 1 points for \* and one point for c (other solutions possible)**



**FRAGE 10 VON 91**

**DLMDSINDA01\_Offen\_mittel/Lektion 02**



What is the purpose of a transducer?

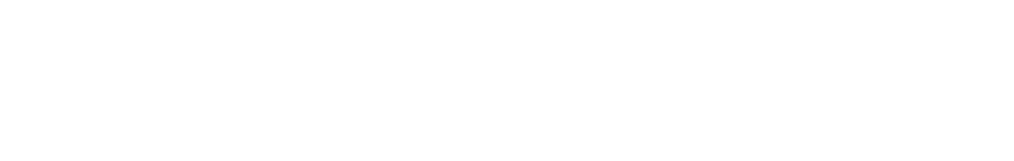
Describe a difference in the formal definition compared to acceptors. How can the output be formally defined?

A transducer ‘transforms’ an input to a certain output **(2 points)**. Additionally to an input alphabet, transducer have an output alphabet **(2 points)**. The output is a set of possible words, i.e. a formal language **(2 points)**.



**FRAGE 11 VON 91**

**DLMDSINDA01\_Offen\_schwer\_F1/Lektion 02**



How can a deterministic finite automaton be formally described? Name and describe each part of your definition.

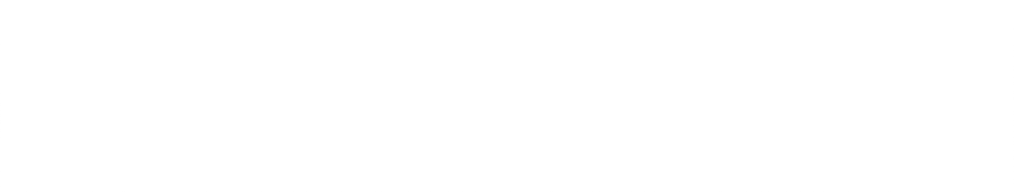
What types of languages can be recognized with finite automata?

A deterministic finite automaton can be formally described by the tuple A={K,Σ,δ,s0,F}. K is a finite set of states, Σ is an alphabet, δ is a total transition function K×Σ→K, thus defined for each possible input, s0∈K is the initial state, F⊆K is a set of final states. **(1 point for each part + 2 points for each description = 15 points)**. Finite automata can recognize regular languages **(3 points)**.



**FRAGE 12 VON 91**

**DLMDSINDA01\_Offen\_schwer\_F1/Lektion 02**



When is a word accepted by an automaton?

What kinds of states can be removed from deterministic automata? Name three different algorithms for the minimization of deterministic finite automata.

A word is accepted by an automaton if and only if one of its final states is reached **(3 points)**. Two types of states can be removed from an automaton: unreachable **(3 points)** and indistinguishable ones **(3 points)**. Type of algorithms for minimization: Hopcroft's algorithm, Moore’s algorithm and Brzozowski's algorithm **(3 points each)**



**FRAGE 13 VON 91**

**DLMDSINDA01\_Offen\_leicht/Lektion 03**



What is the reachability set of a marking m of a Petri net N? What is the reachability set of a Petri net N?

The reachability set R(m) of a marking m in a Petri net N is the set of all markings m’ that are reachable from m **(3 points)**. The reachability set R(N) of a Petri net N is defined by the set of all markings m’ that are reachable from the initial marking m0 **(3 points)**.



**FRAGE 14 VON 91**

**DLMDSINDA01\_Offen\_leicht/Lektion 03**



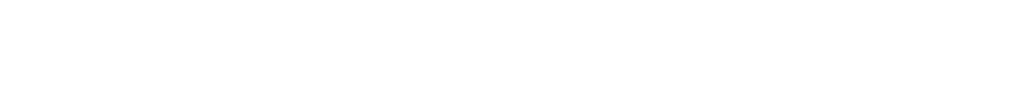
Name and describe two types of invariants in the context of Petri nets.

Place-invariant (P-invariant) **(1 point)** means the property that a linear combination of the number of place tokens ni is invariant with respect to fired transitions **(2 points)**. Transition-invariant (T- invariant) **(1 point)** means that the execution of a sequence of transitions always leads back to the starting marking, while the order of transitions is arbitrary as long as there are enough tokens in each preset **(2 points)**.



**FRAGE 15 VON 91**

**DLMDSINDA01\_Offen\_mittel/Lektion 03**



Describe a bipartite graph with respect to the associated sets.

A bipartite graph is a graph with two disjoint and independent sets of vertices U and V **(2 points)** and is represented by the triple G=(U,V,E) **(2 points)**. An edge always connects a vertex in U with one in V **(2 points)**.



**FRAGE 16 VON 91**

**DLMDSINDA01\_Offen\_mittel/Lektion 03**



Describe a Petri net formally with respect to the associated sets.

A Petri net is a bipartite graph **(1.5 points)** described by the triple (P,T,F), where P is a finite set of places represented by circles **(1.5 points)**,

T is a finite set of transitions represented as long narrow rectangles **(1.5 points)**, F is a set of flow relations also called arcs, represented as arrows **(1.5 points)**.



**FRAGE 17 VON 91**

**DLMDSINDA01\_Offen\_schwer\_F1/Lektion 03**



Name and describe three different types of Petri nets.

Possible types:

**Condition-Event nets**: A condition-event net is defined by the limitation for each place to have maximal one token. If a particular place is set with a token it can be seen as a condition that is satisfied, which leads to an event (the firing of a transition).

**Workflow nets**: A workflow net is defined by the properties that it has exactly one initial and one final place xi and xo, respectively, where ●xi =∅ and xo●=∅. Furthermore, each place p∈P and transition t∈T is part of the path from xi to xo.

**Place-transition nets**: A place transition net is a Petri net extended by a weight function W:F→ N defining the weight of each arc f∈F. If and only if the numbers of tokens are set at the input places a transition becomes enabled and will be able to fire, while it consumes that very amount of tokens and produces as many new ones in the output place as defined by the particular weight.

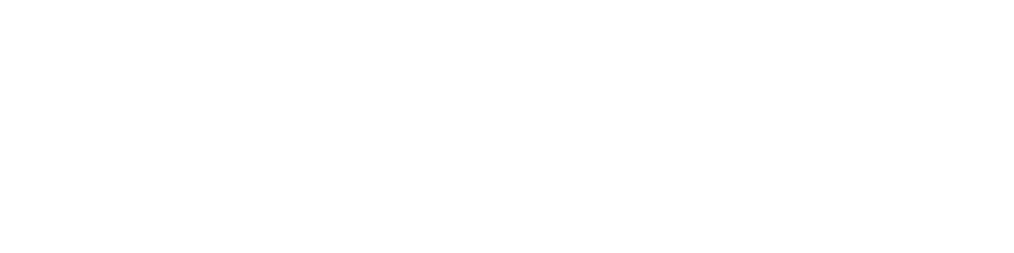
**Colored Petri nets**: A colored Petri net differentiates multiple types of markers, which allows more complex conditions when transitions can fire.

# (3 points for type + 3 points for description)



**FRAGE 18 VON 91**

**DLMDSINDA01\_Offen\_schwer\_F1/Lektion 03**



Consider a condition-event net.

What does a representation of a transition as a vector capture?

What are the possible values for the representation of transitions as a vector and when do these values occur?

How can the successive marking after firing of a transition t be calculated using this representation?

The vectors capture the consumption and production of tokens in the places pi after firing **(3 points)**.

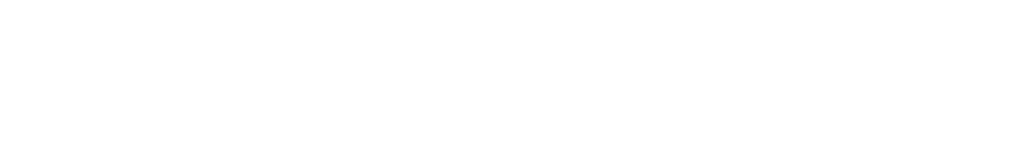
The possible values are +1 **(1 point)** for a place that is element of the postset and not of the preset of t **(3 points)**, -1 **(1 point)** for a place that is element of the preset and not of the postset of t **(3 points)** and 0 **(1 point)** otherwise **(3 points)**.

The susscessive marking can be calculated by means of vector addition **(3 points)**.



**FRAGE 19 VON 91**

**DLMDSINDA01\_Offen\_leicht/Lektion 04**



Even if the terms Markov process and Markov chain are often used interchangeably, what difference is sometimes made with respect to the modeled processes?

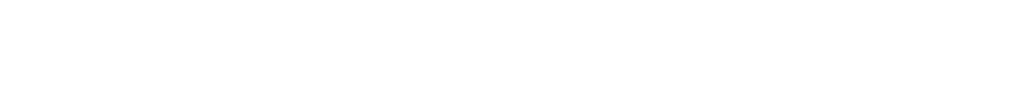
Sometimes a differentiation of continuous (Markov process) **(3 points)** and discrete processes

**(Markov chain**) is made **(3 points)**.



**FRAGE 20 VON 91**

**DLMDSINDA01\_Offen\_leicht/Lektion 04**



What are the two main parts of a queuing process?

A basic queuing process consists of two parts: a customer that requests **(3 points)** and a server that delivers a certain service **(3 points)**.



**FRAGE 21 VON 91**

**DLMDSINDA01\_Offen\_mittel/Lektion 04**



When is a Markov process called homogenous?

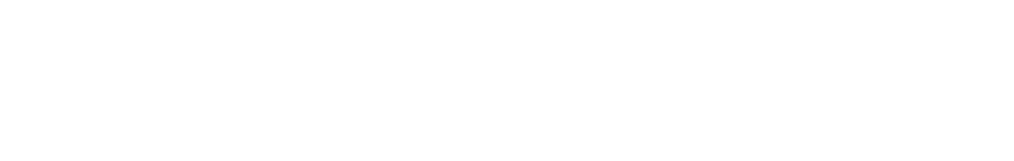
Describe, what P(a|b) means in the context of probability theory.

It is called homogenous if the transition probabilities do not change **(3 points)**. P(a|b) is the conditional probability of a given b **(3 points)**.



**FRAGE 22 VON 91**

**DLMDSINDA01\_Offen\_mittel/Lektion 04**



Suppose a scenario of a fuel station where four cars can be served per minute. The average number of cars is ten.

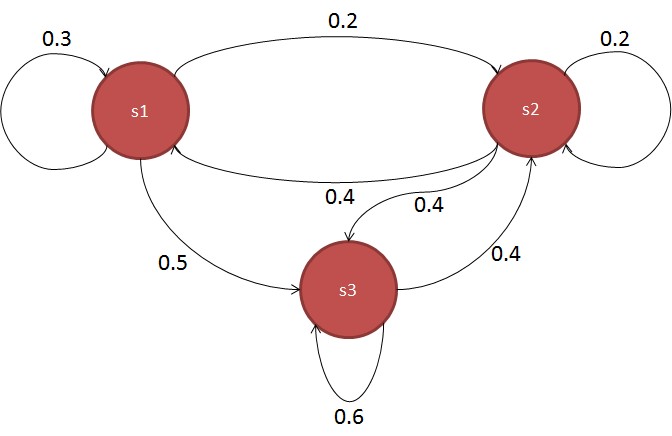
Calculate the average waiting time using Little's law.

W=L/λ=(10 cars in average)/(4 customers served per minute)=2.5 minutes waiting time. **(2 points for correct equation, two points for identification of correct values, 2 points for result)**



**FRAGE 23 VON 91**

**DLMDSINDA01\_Offen\_schwer\_F1/Lektion 04**



Determine the transition matix of the transition graph shown in the figure.

solution in figure solution

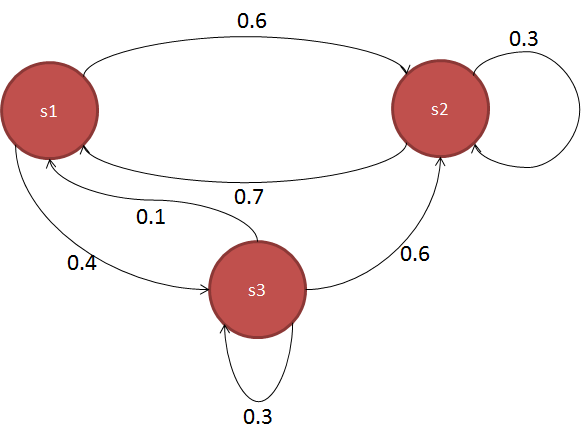
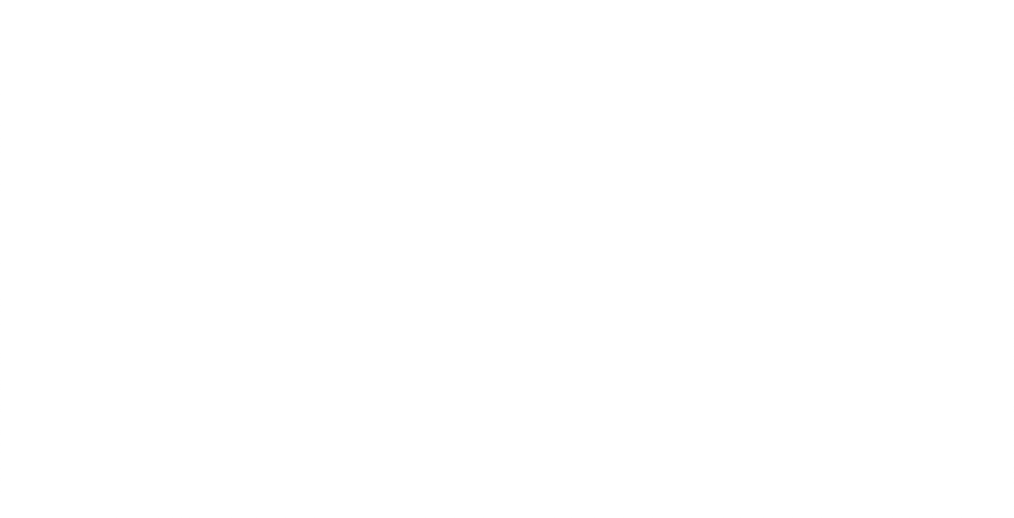


# 2 points for each correct entry of the matrix.



**FRAGE 24 VON 91**

**DLMDSINDA01\_Offen\_schwer\_F1/Lektion 04**



Determine the transition matix of the transition graph shown in the figure.

solution in figure solution

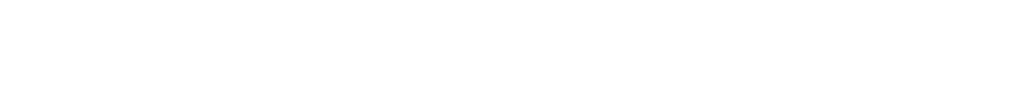


# 2 points for each correct entry of the matrix.



**FRAGE 25 VON 91**

**DLMDSINDA01\_Offen\_leicht/Lektion 05**



Describe two possible scenarios of continuous processes.

decay of radioactive elements, the flow of water over a dam or the amount of alcohol that is produced during fermentation **(3 points for each example)**



**FRAGE 26 VON 91**

**DLMDSINDA01\_Offen\_leicht/Lektion 05**



Describe the difference between discrete-event and discrete simulation.

The former relies upon systems that change based on events **(3 points)**, while the latter considers phenomena that are countable such as the number of animals that passed through a gate **(3 points)**.



**FRAGE 27 VON 91**

**DLMDSINDA01\_Offen\_mittel/Lektion 05**



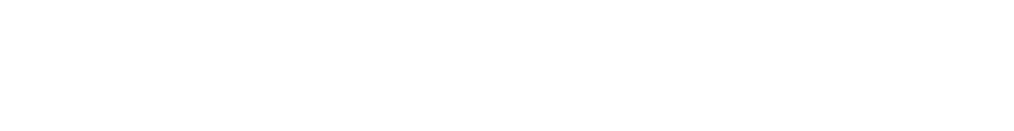
Describe the difference between next-event time progression and fixed- increment time progression.

Next-event time progression describes the approach where the simulation time jumps to the time when the next event occurs under the assumption that the system’s state is constant between two events **(3 points)**. Fixed-increment time progression follows a different approach and splits the time up into discrete time steps that define the points where the system’s state is updated **(3 points)**.



**FRAGE 28 VON 91**

**DLMDSINDA01\_Offen\_mittel/Lektion 05**



What are two main issues that have to be considered when analyzing a discrete-event system? Name and briefly describe them.

Autocorrelation, thus possible statistical independence of events, **(3 points)** and the initial conditions of the system, which might have a non-negligible impact on the performance **(3 points)**



**FRAGE 29 VON 91**

**DLMDSINDA01\_Offen\_schwer\_F2/Lektion 05**



Describe the difference between an activity and a delay in the context of discrete-event simulation based on three criteria.

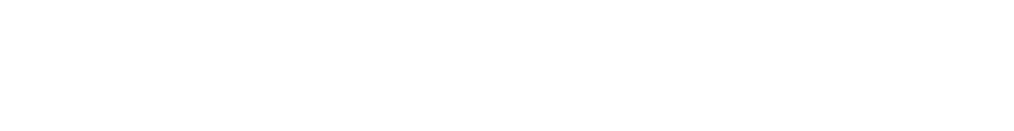
Activities are called unconditional waits because the start and end point is known (even if they may be defined stochastically) **(3 points)**, while delays are conditional waits because their end depends on a system’s condition **(3 points)**. The end of activities is known and thus represents an event that is placed on the future event list **(3 points)**, which is called primary event **(3 points)**.

The entity associated to a delay is put on a ‘waiting’ list **(3 points)** and its completion is called secondary event **(3 points)**.



**FRAGE 30 VON 91**

**DLMDSINDA01\_Offen\_schwer\_F2/Lektion 05**



Describe the five seperate steps of event scheduling in the context of discrete-event simulation.

There are five major steps that are needed for the event scheduling. In a first step, the event notice for the imminent event is removed from the future event list **(3 points)**. Afterwards, the clock is advanced to the event time of the removed event **(3 points)**. In the third step, the imminent event is executed, which results in an update of the system’s state, a change of the entity attributes and set memberships **(3 points)**. Event notices of new future events are placed into the future event list afterwards **(3 points)** and finally, the statistics and counters of the simulation are updated **(3 points)**. **(+3 points for the correct order of all steps)**



**FRAGE 31 VON 91**

**DLMDSINDA01\_Offen\_leicht/Lektion 06**



Describe the purpose of a controller in your own words.

A controller acts as a ‘corrector’ by monitoring process variables (PV) **(2 points)** and by comparing them with set points (SP) **(2 points)**, which serve as references, to produce control actions in terms of a feedback mechanism **(2 points)**.



**FRAGE 32 VON 91**

**DLMDSINDA01\_Offen\_leicht/Lektion 06**



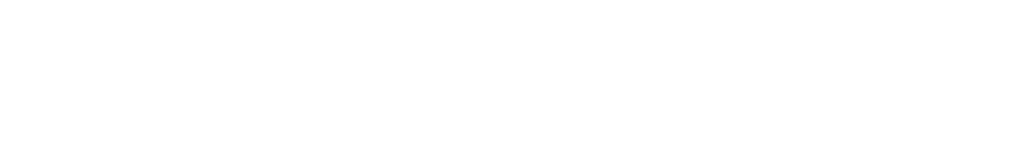
What is the main difference between an open and a closed control-loop? Name and briefly describe it.

In a closed control-loop the controller monitors process variables (PV) and compares them with set points (SP), which serve as references, to produce control actions in terms of a feedback mechanism **(3 points)**. An open-loop is created by leaving out the feedback signal **(3 points)**.



**FRAGE 33 VON 91**

**DLMDSINDA01\_Offen\_mittel/Lektion 06**



What are the two main types of events that can occur in discrete-event systems?

Describe their properties.

Controllable events **(1 point)** are events that can be managed by the supervisor **(2 points)**, while uncontrollable events **(1 point)** are those, where no control authority is available such as machine breakdown, malfunctions, etc **(2 points)**.



**FRAGE 34 VON 91**

**DLMDSINDA01\_Offen\_mittel/Lektion 06**



How is a plant process formally defined?

A process G can be defined as the triple P=(Σ, Lp, Lm) **(1.5 points)**, where Σ is an alphabet **(1.5 points)**,

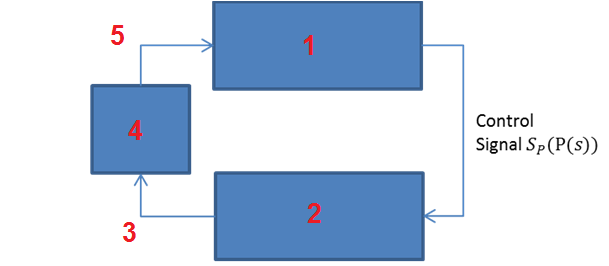
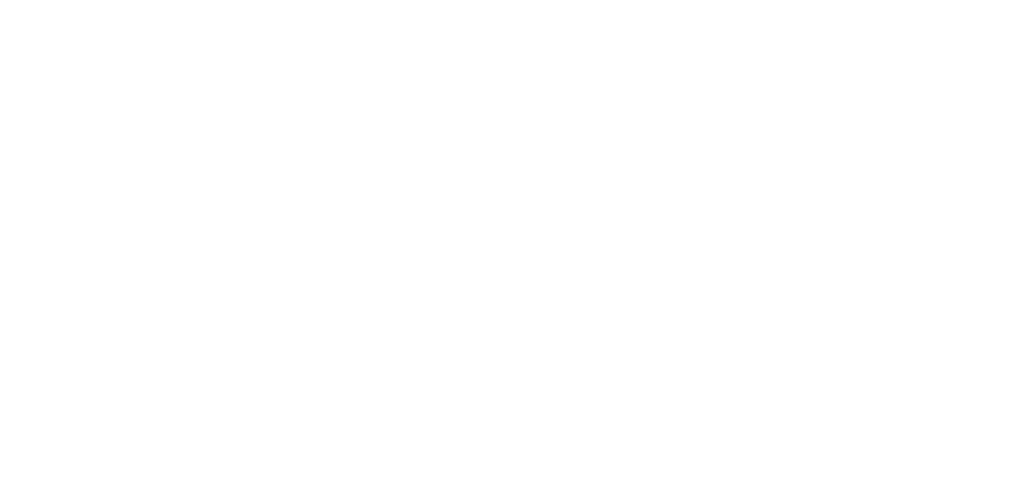
Lp is a language representing all possible tasks **(1.5 points),**

Lm ⊆ Lp is the language representing all completed tasks, called marked language **(1.5 points)**.



**FRAGE 35 VON 91**

**DLMDSINDA01\_Offen\_schwer\_F2/Lektion 06**



Name the components 1-5 of the figure representing supervisory control under partial observation.

What kinds of events are considered by the supervisor?

1. supervisor,
2. plant,
3. events,
4. projector,
5. natural projection P(S) of events s

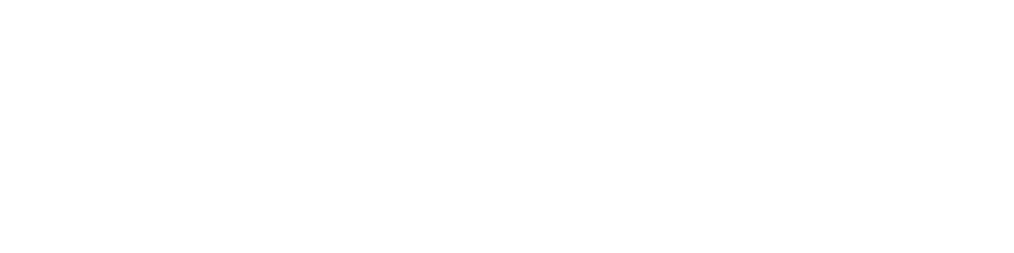
# (3 points each).

The supervisor can only consider the observable events. **(3 points)**



**FRAGE 36 VON 91**

**DLMDSINDA01\_Offen\_schwer\_F2/Lektion 06**



Let Ξ be a subset of the set of controllable events containing events that have to be initiated.

Define the properties termination and confluence in this context. What is the result if a plant does not terminate?

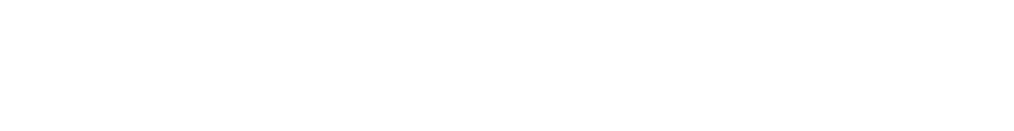
What happens if a plant is both Ξ-terminating and Ξ-confluent? Give an example for an event that has to be initiated.

A terminating system stabilizes after a sufficiently long time, i.e. there is a sequence of events of finite length after some input is given **(3 points)**. If G is Ξ-terminating there is only a finite sequence of events of Ξ allowed to occur **(3 points)**. It is clear, why systems that do not hold that criterion create problems during implementation. If the number of events that should occur next and be chosen by the supervisor is infinitely large, an implementation would be stuck inside a loop **(3 points)**. A confluent system ensures that states with the same future are reached by all implementations by the occurrence of events from Ξ only, independently from a chosen event **(3 points)**. If G is both Ξ-terminating and Ξ-confluent, then states with the same future will be reached by all Ξ-implementations starting from a reachable state for all events of Ξ **(3 points)**. An example for an event that has to be initiated can be a start command using a switch to do a self check or similar **(3 points for an appropriate example).**



**FRAGE 37 VON 91**

**DLMDSINDA01\_Offen\_leicht/Lektion 07**



Describe a latent error in your own words with respect to the impact on the system's operation.

A latent error is an error that did not have any impact on the system’s operation yet **(3 point)**. It becomes an effective error after being used for operation **(3 points)**.



**FRAGE 38 VON 91**

**DLMDSINDA01\_Offen\_leicht/Lektion 07**



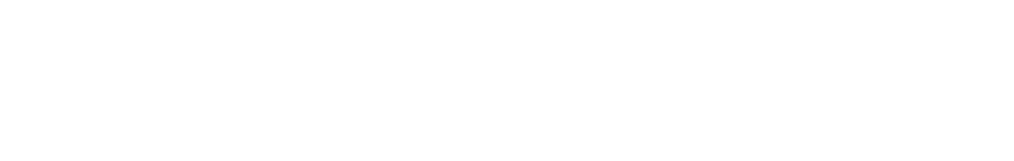
Describe the purpose of monitoring and of fault diagnosis.

While monitoring means the detection that a fault occurred **(3 points)**, latter means the search of the origin of it **(3 points)**.



**FRAGE 39 VON 91**

**DLMDSINDA01\_Offen\_mittel/Lektion 07**



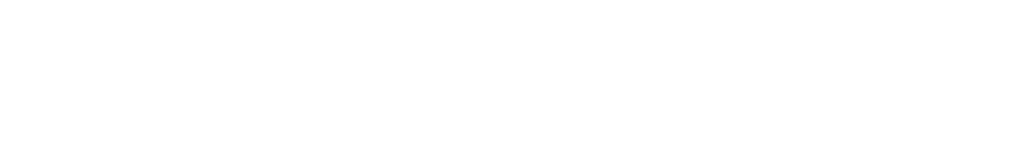
What are the two types of systems that can be distibguished using a composition of monitoring and supervision for production planning? Describe them in your own words.

One can differentiate such systems between on-line **(1 point)**, which means the reconfiguration during the exploitation phase after failure detection **(2 points)**, and off-line **(1 point)**, which means the investigation of strategies to eliminate the impact of failures **(2 points)**.



**FRAGE 40 VON 91**

**DLMDSINDA01\_Offen\_mittel/Lektion 07**



How can hierarchical supervision and monitoring of production systems be described?

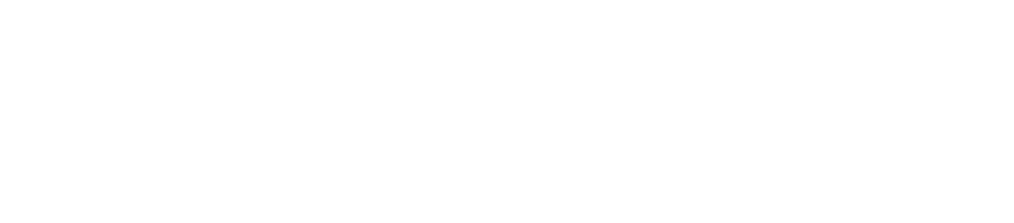
Describe also the task of each component.

Using hierarchical supervision and monitoring, the three parts – monitoring, control and supervision – are composed in a modular way, which allows a more flexible processing of failures **(3 points)**. While the monitoring takes care of detection and diagnosis **(1 point)**, the supervision performs decisions **(1 point)** and the controller executes control, resumption or emergency actions **(1 point)**.



**FRAGE 41 VON 91**

**DLMDSINDA01\_Offen\_schwer\_F2/Lektion 07**



Describe the fault diagnosis problem.

Describe the term "trace" in that context in your own words and how the solution of the fault diagnosis problem is defined in that regard.

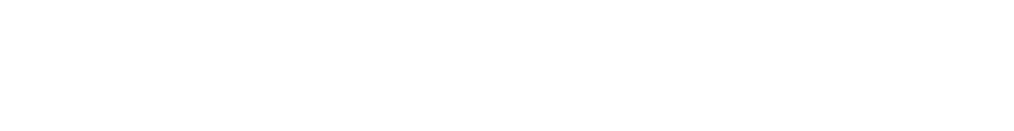
If the set of fault diagnosers represented as finite automata has been obtained, how can they be composed to yield the classical diagnoser?

Generally, the fault diagnosis problem for discrete-event systems can be described as the provision of a set of all possible faults **(3 points)** for a recorded sequence of observations σ **(3 points)**. If there is at least one sequence of events ω in the plant G that contains a fault F and for which the sequence of observable events Obs(ω) equals the sequence of recorded observations σ for F, Obs(ω) is called trace of F **(3 points)**. The set of traces Trc(F) of F consists of all such sequences Obs(ω) **(3 points)**, i.e. F is a solution for the diagnosis problem if σ∈ Trc(F) **(3 points)**. To yield the classical diagnoser the automata are composed using parallel composition **(3 points).**



**FRAGE 42 VON 91**

**DLMDSINDA01\_Offen\_schwer\_F2/Lektion 07**



Describe the concepts of de-centralized and distributed supervisory control. Name one advantage and one disadvantage of the de-centralized approach.

A decentralized approach for supervision consists of a division of the supervisory task into multiple subtasks that are supervised in a de-centralized manner **(3 points)**. To obtain a supervision of the complete system the single decentralized supervisors work concurrently **(3 points)**. The distributed supervisory control approach uses a distribution among individual agents by means of a decomposition of a synthesized monolithic supervisor into local controllers **(3 points)**, which has to show the same global behavior as the underlying monolithic supervisor **(3 points)**. De- centralized supervisors are easier to maintain and to modify due to the reduced complexity of the single supervisors **(3 points)**. A possible disadvantage of this approach is the risk of conflicts and thus, a blocking behavior **(3 points)**.



When was industrial automation introduced?

**Wählen Sie eine Antwort:**

*In 1913*

In 1492

3200 B.C.

In 1860



**FRAGE 43 VON 91**

**DLMDSINDA01\_MC\_leicht/Lektion 01**



**FRAGE 44 VON 91**

**DLMDSINDA01\_MC\_leicht/Lektion 01**



How was the first industrial automation referred to?

**Wählen Sie eine Antwort:**

*Fixed automation* Intelligent automation Flexible automation Programmable automation



Which automation paradigm is best suited to produce many parts of a

product with very low variety?

**Wählen Sie eine Antwort:**

Programmable automation *Fixed automation*

Flexible automation

Electric automation



**FRAGE 45 VON 91**

**DLMDSINDA01\_MC\_leicht/Lektion 01**



Which of the following sequences describes the Automation Pyramid from

the bottom-up?

**Wählen Sie eine Antwort:**

1. Production process
2. Monitoring and Supervising
3. Sensing and Manipulating
4. Manufacturing Operations Management
5. Business planning and logistics
6. Production process
7. Sensing and Manipulating
8. Manufacturing Operations Management
9. Monitoring and Supervising
10. Business planning and logistics
11. Business planning and logistics
12. Production process
13. Monitoring and Supervising
14. Sensing and Manipulating
15. Manufacturing Operations Management
16. *Production process*
17. *Sensing and Manipulating*
18. *Monitoring and Supervising*
19. *Manufacturing Operations Management*
20. *Business planning and logistics*



**FRAGE 46 VON 91**

**DLMDSINDA01\_MC\_mittel/Lektion 01**



**FRAGE 47 VON 91**

**DLMDSINDA01\_MC\_mittel/Lektion 01**



Which of the following tasks is **not** a task of level 0 devices of the

automation pyramid?

**Wählen Sie eine Antwort:**

Control process outputs Measuring process variables Real-time communciation *Supervisory control*



**FRAGE 48 VON 91**

**DLMDSINDA01\_MC\_schwer/Lektion 01**



Which of the following technologies characterizes Industry 4.5?

**Wählen Sie eine Antwort:**

CPS CPPS SCADA *IIA*



**FRAGE 49 VON 91**

**DLMDSINDA01\_MC\_schwer/Lektion 01**



Which of the following technologies characterizes Industry 4.0?

**Wählen Sie eine Antwort:**

IIA RPA BPA *CPS*



**FRAGE 50 VON 91**

**DLMDSINDA01\_MC\_leicht/Lektion 02**



Which of the following types of languages is accepted by finite automata?

**Wählen Sie eine Antwort:**

Context-free languages Recursively enumerable languages Context-sensitive languages *Regular languages*



**FRAGE 51 VON 91**

**DLMDSINDA01\_MC\_leicht/Lektion 02**



A formal grammar is …

**Wählen Sie eine Antwort:**

*a generator of a formal language.* an acceptor of a formal language. a formal language.

a recognizer of a formal language.



**FRAGE 52 VON 91**

**DLMDSINDA01\_MC\_leicht/Lektion 02**



An automaton is …

**Wählen Sie eine Antwort:**

a formal language.

*an acceptor of a formal language*. a generator of a formal language. a Chomsky hierarchy.



Which of the following types of languages is accepted by linear bounded

automata?

**Wählen Sie eine Antwort:**

Context-free languages *Context-sensitive languages* Regular languages

Recursively enumerable languages



**FRAGE 53 VON 91**

**DLMDSINDA01\_MC\_mittel/Lektion 02**



**FRAGE 54 VON 91**

**DLMDSINDA01\_MC\_mittel/Lektion 02**



Which of the following types of languages is accepted by pushdown

automata?

**Wählen Sie eine Antwort:**

Regular languages

Context-sensitive languages Recursively enumerable languages *Context-free languages*



Which of the following sentences is correct?

**Wählen Sie eine Antwort:**

Every context-sensitive language is also context-free. Every context-sensitive language is also regular.

*Every context-free language is also context-sensitive.*

Every context-free language is also regular.



**FRAGE 55 VON 91**

**DLMDSINDA01\_MC\_schwer/Lektion 02**



**FRAGE 56 VON 91**

**DLMDSINDA01\_MC\_schwer/Lektion 02**



Which of the following words does **not** belong to the regular expression

R=a(b|c)\*?

**Wählen Sie eine Antwort:**

abcb accc *abba* abbb



**FRAGE 57 VON 91**

**DLMDSINDA01\_MC\_leicht/Lektion 03**



Which of the following components of a Petri net represent the ressources of

the model?

**Wählen Sie eine Antwort:**

*Tokens* Markings Transitions Places



**FRAGE 58 VON 91**

**DLMDSINDA01\_MC\_leicht/Lektion 03**



Which of the following components of a Petri net represent the activities of

the model?

**Wählen Sie eine Antwort:**

*Transitions* Tokens Places Markings



**FRAGE 59 VON 91**

**DLMDSINDA01\_MC\_leicht/Lektion 03**



Which of the following components of a Petri net represent the storage

components of the model?

**Wählen Sie eine Antwort:**

Tokens Markings *Places* Transitions



**FRAGE 60 VON 91**

**DLMDSINDA01\_MC\_mittel/Lektion 03**



How many rows does a transition represented as a vector have?

**Wählen Sie eine Antwort:**

*As many rows as there are places in the net.*

As many rows as there are transitions in the net. As many rows as there are arcs in the net.

As many rows as there are tokens in the net.



When does a Petri net terminate?

**Wählen Sie eine Antwort:**

A Petri net terminates if there is at least one enabled transition for each reachable marking.

*A Petri net terminates if each sequence of transitions starting in marking m ends in a deadlock at some time.*

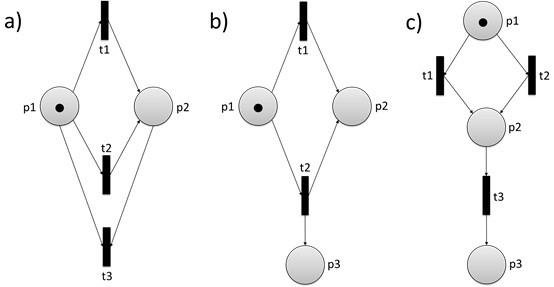
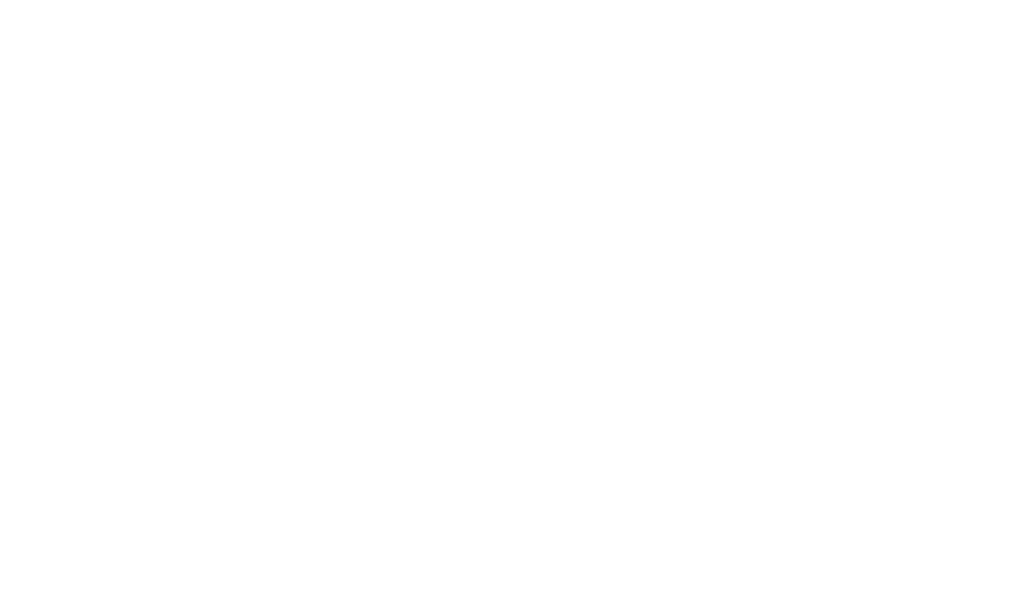
A Petri net terminates if there is a sequence of transitions for each reachable marking m, so that t is enabled in m’.

A Petri net terminates if it is not marked with more than k tokens at any reachable marking.



**FRAGE 61 VON 91**

**DLMDSINDA01\_MC\_mittel/Lektion 03**



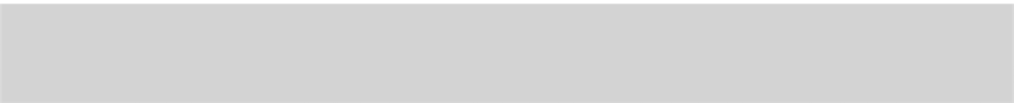
Which of the shown Petri nets does **not** contain a deadlock?

**Wählen Sie eine Antwort:**

c a

none

*b*



**FRAGE 63 VON 91**

**DLMDSINDA01\_MC\_schwer/Lektion 03**



**FRAGE 62 VON 91**

**DLMDSINDA01\_MC\_schwer/Lektion 03**



Two or more transitions follow a place, so that only one of the transitions

can fire when the place is marked but not both. How is such a construction called?

**Wählen Sie eine Antwort:**

ADD-join ADD-split *XOR-split* XOR-join



**FRAGE 64 VON 91**

**DLMDSINDA01\_MC\_leicht/Lektion 04**



How is a set of timed words called?

**Wählen Sie eine Antwort:**

*Timed language* Timed expression Timed automaton Timed grammar



**FRAGE 65 VON 91**

**DLMDSINDA01\_MC\_leicht/Lektion 04**



On which notation is the classification of queuing processes based?

**Wählen Sie eine Antwort:**

Kerber notation *Kendall notation* Kleene notation Kasner notation



**FRAGE 66 VON 91**

**DLMDSINDA01\_MC\_leicht/Lektion 04**



How is the waiting area of a queuing process called?

**Wählen Sie eine Antwort:**

Node Distribution *Buffer* Storage



**FRAGE 67 VON 91**

**DLMDSINDA01\_MC\_mittel/Lektion 04**



When is a Markov process called irreducible?

**Wählen Sie eine Antwort:**

If it is almost safe that all states are reached again after leaving them.

*If all states can be reached from any other state by a sequence of transitions.* If it returns to the same state after a sequence of finite length.

If one of ist states can never be left after it is reached.



**FRAGE 68 VON 91**

**DLMDSINDA01\_MC\_mittel/Lektion 04**



Which type of timed Petri net incorporates a random firing rate?

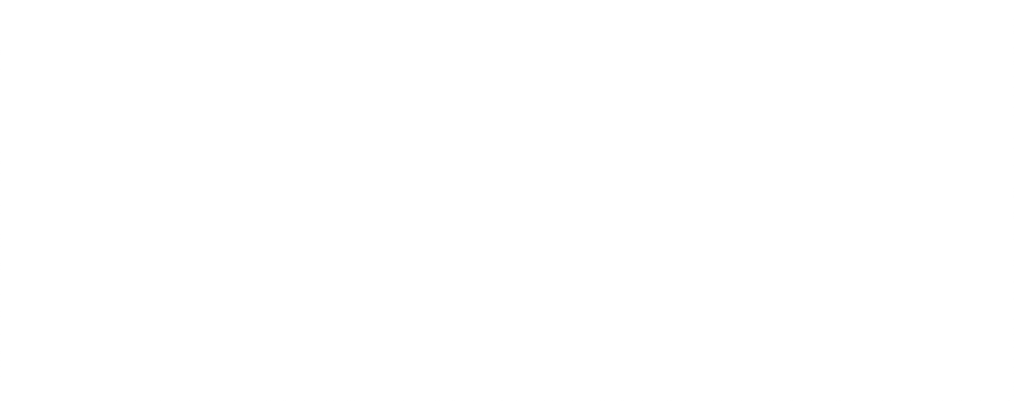
**Wählen Sie eine Antwort:**

*Stochastic Petri net* Timed places Petri net Timed arcs Petri net Deterministic Petri net



**FRAGE 69 VON 91**

**DLMDSINDA01\_MC\_schwer/Lektion 04**



Which of the following is a correct formulation of Little's law in the context of

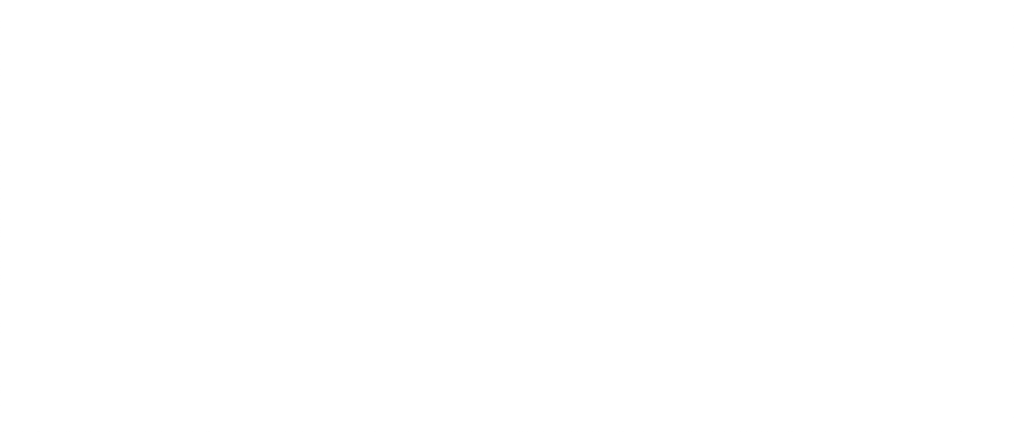
queuing theory, where L, λ and W represent the average number of customers, the average time spent and the average arrival rate, respectively?

**Wählen Sie eine Antwort:**

*L=λW*

L=λ/W λ=L+W

W=λ/L



What is a so-called firing pre-condition?

**Wählen Sie eine Antwort:**

A time delay added to the markings, for which the pre-conditions have to hold before completing the firing.

*A time delay added to the transitions, for which the pre-conditions have to hold before completing the firing.*

A time delay added to the places, for which the pre-conditions have to hold before completing the firing.

A time delay added to the arcs, for which the pre-conditions have to hold before completing the firing.



**FRAGE 70 VON 91**

**DLMDSINDA01\_MC\_schwer/Lektion 04**



**FRAGE 71 VON 91**

**DLMDSINDA01\_MC\_leicht/Lektion 05**



What is a primary event in the context of discrete-event simulation?

**Wählen Sie eine Antwort:**

An event that is finished.

An event that is placed on a waiting list. The first event of a simulation.

*An event that is placed on the future event list.*



What is a secondary event in the context of discrete-event simulation?

**Wählen Sie eine Antwort:**

An event that is finished.

The second event of a simulation.

*An event that is placed on a waiting list.*

An event that is placed on the future event list.



**FRAGE 72 VON 91**

**DLMDSINDA01\_MC\_leicht/Lektion 05**



**FRAGE 73 VON 91**

**DLMDSINDA01\_MC\_leicht/Lektion 05**



The initial conditions and the final event of a simulation are known.

How is this type of simulation called?

**Wählen Sie eine Antwort:**

Non-terminating simulation *Transient simulation* Steady-state simulation Continuous simulation



**FRAGE 74 VON 91**

**DLMDSINDA01\_MC\_mittel/Lektion 05**



What does continuous simulation use for the update of a system's state

variables?

**Wählen Sie eine Antwort:**

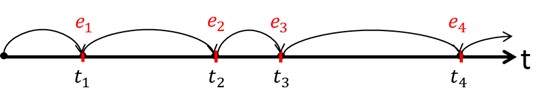
Activities

*Differential equations* Difference equations Events



**FRAGE 75 VON 91**

**DLMDSINDA01\_MC\_mittel/Lektion 05**



What type of time progession does the figure show, where e\_i represent

events?

**Wählen Sie eine Antwort:**

Continuous time progression Fixed-increment time progression Discrete time progression

*Next-event time progression*



What does the prediction interval of a performance analysis yield?

**Wählen Sie eine Antwort:**

The prediction interval yields an estimation of the mean of the data with a certain probability.

The prediction interval yields a region in which the performance parameter is included with a certain probability.

*The prediction interval yields a region in which the future samples fall with a certain probability.*

The prediction interval yields an estimation of the median of the data with a certain probability.



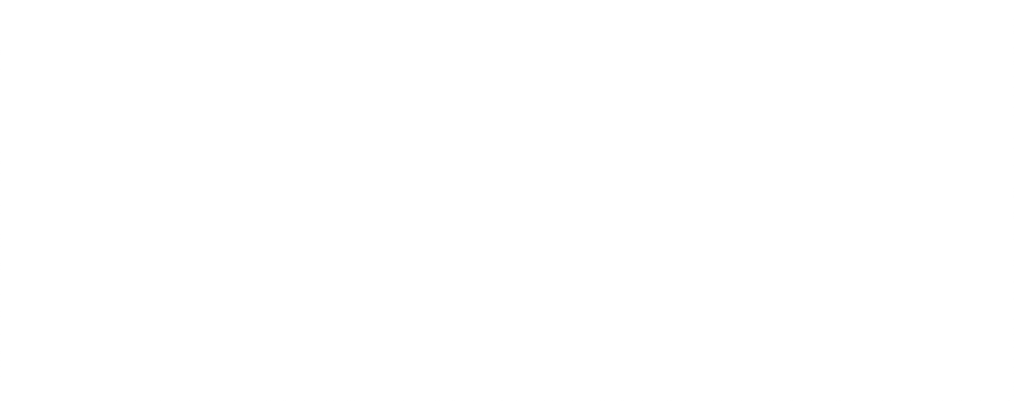
**FRAGE 76 VON 91**

**DLMDSINDA01\_MC\_schwer/Lektion 05**



**FRAGE 77 VON 91**

**DLMDSINDA01\_MC\_schwer/Lektion 05**



What does the confidence interval of a performance analysis yield?

**Wählen Sie eine Antwort:**

*The confidence interval yields a region in which the performance parameter is included with a certain probability.*

The confidence interval yields an estimation of the mean of the data with a certain probability.

The confidence interval yields an estimation of the median of the data with a certain probability.

The confidence interval yields a region in which the future samples fall with a certain probability.



Which of the following is an **undesirable** behavior?

**Wählen Sie eine Antwort:**

Violating a necessary ordering of events. The placement of parts into a full buffer. Violation of safety conditions.

*Behaviors that lead to some sort of deadlock of the process.*



**FRAGE 78 VON 91**

**DLMDSINDA01\_MC\_leicht/Lektion 06**



**FRAGE 79 VON 91**

**DLMDSINDA01\_MC\_leicht/Lektion 06**



What kinds of events can a supervisor "see"?

**Wählen Sie eine Antwort:**

*Observable events* Uncontrollable events Controllable events All events



A specification defines a state of a plant, which is represented as a finite

automaton, to be illegal. How can that be achieved?

**Wählen Sie eine Antwort:**

Removing transitions to marked state Parallel composition with itself Product composition with itself

*Removing state and associated transitions*



**FRAGE 80 VON 91**

**DLMDSINDA01\_MC\_leicht/Lektion 06**



**FRAGE 81 VON 91**

**DLMDSINDA01\_MC\_mittel/Lektion 06**



How is the language of a plant process called that represents all completed

tasks?

**Wählen Sie eine Antwort:**

Prefix-closed language Final language Complete language *Marked language*



The task of a supervisor is …

**Wählen Sie eine Antwort:**

to exclude all types of behaviors of the plant G that do not belong to the observable ones. *to exclude all types of behaviors of the plant G that do not belong to the admissible ones.*

to exclude all types of behaviors of the plant G that do not belong to the uncontrollable ones.

to exclude all types of behaviors of the plant G that do not belong to the unobservable ones.



**FRAGE 82 VON 91**

**DLMDSINDA01\_MC\_mittel/Lektion 06**



**FRAGE 83 VON 91**

**DLMDSINDA01\_MC\_schwer/Lektion 06**



How is a state of an automaton called, for which there is a sequence of

transitions that leads to a marked state?

**Wählen Sie eine Antwort:**

Marked state Accessible state Reachable state *Co-accessible state*



**FRAGE 84 VON 91**

**DLMDSINDA01\_MC\_schwer/Lektion 06**



What does the property forcibly nonblocking mean?

**Wählen Sie eine Antwort:**

A state is called forcibly nonblocking if a transition to another state is possible at any time.

*A state is called forcibly nonblocking if a marked state is reached after a sequence of events of finite length.*

A state is called forcibly nonblocking if a marked state is reached after a sequence of events of infinite length.

A state is called forcibly nonblocking if no transition to another state is possible at any time.



**FRAGE 85 VON 91**

**DLMDSINDA01\_MC\_leicht/Lektion 07**



The deviation between actual and nominal value of a parameter is called …

**Wählen Sie eine Antwort:**

a malfunction. a failure.

a fault.

*a defect.*



**FRAGE 86 VON 91**

**DLMDSINDA01\_MC\_leicht/Lektion 07**



How are failures generally modeled in discrete-event systems?

**Wählen Sie eine Antwort:**

*As uncontrollable events* As observable events As unobservable events As controllable events



**FRAGE 87 VON 91**

**DLMDSINDA01\_MC\_leicht/Lektion 07**



How is an automaton using hierarchically nested states called?

**Wählen Sie eine Antwort:**

Pushdown automaton Turing machine *Hierarchical state machine* Linear bounded automaton



How can monitoring be formally described?

**Wählen Sie eine Antwort:**

*Assigning an observable or empty event to each event.* Assigning a controllable event to each uncontrollable event. Assigning a controllable event to each event.

Assigning an uncontrollable event to each event.



**FRAGE 88 VON 91**

**DLMDSINDA01\_MC\_mittel/Lektion 07**



**FRAGE 89 VON 91**

**DLMDSINDA01\_MC\_mittel/Lektion 07**



Which of the following is an algorithm for the distribution of the global control

task among individual agents by means of a decomposition of a synthesized monolithic supervisor into local controllers?

**Wählen Sie eine Antwort:**

Model-based optimization Adaptive supervisory control *Supervisor localization*

De-centralization



What is the task of the first component of the control-loop used in adaptive

supervisory control?

**Wählen Sie eine Antwort:**

The estimation of the set of all operation modes possible in the future that are compatible with the current state.

The activation of fault diagnosers corresponding to the estimated faults of the system. The activation of feedback controllers corresponding to the estimated modes of operation.

*The estimation of the set of all operation modes compatible with the observations monitored in the past.*



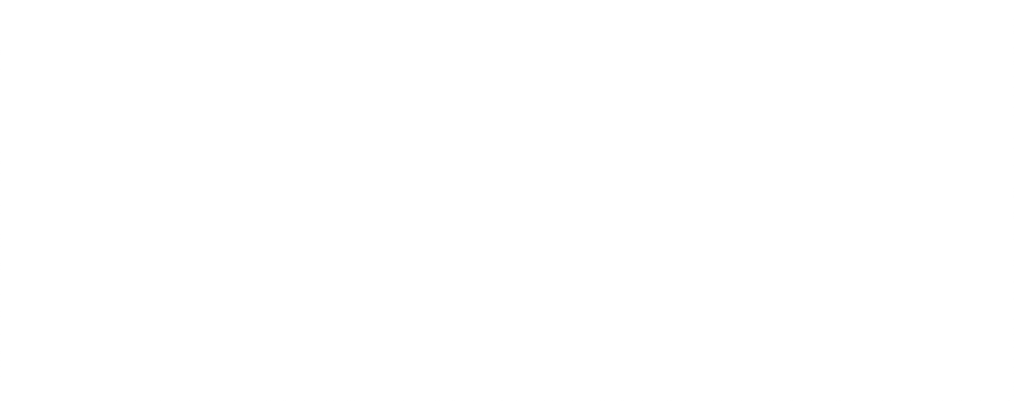
**FRAGE 90 VON 91**

**DLMDSINDA01\_MC\_schwer/Lektion 07**



**FRAGE 91 VON 91**

**DLMDSINDA01\_MC\_schwer/Lektion 07**



What is the task of the second component of the control-loop used in

adaptive supervisory control?

**Wählen Sie eine Antwort:**

The activation of fault diagnosers corresponding to the estimated faults of the system.

The estimation of the set of all operation modes possible in the future that are compatible with the current state.

The estimation of the set of all operation modes compatible with the observations monitored in the past.

*The activation of feedback controllers corresponding to the estimated modes of operation*.