Technology
Arts Sciences
TH Köln

Course Manual STE

Control System Technology

Version: 3 | Last Change: 30.09.2019 14:20 | Draft: 0 | Status: vom verantwortlichen Dozent freigegeben

General information

Long name	Control System Technology
Approving CModule	STE_BaET
Responsible	Prof. Dr. Stefan Kreiser Professor Fakultät IME
Valid from	winter semester 2022/23
Level	Bachelor
Semester in the year	winter semester
Duration	Semester
Hours in self-study	78
ECTS	5
Professors	Prof. Dr. Stefan Kreiser Professor Fakultät IME Kellersohn
Requirements	basic programming skills (procedural language) sampling theorem Boolean algebra discretization of continuous data coding of data finite state machines
Language	German
Separate final exam	Yes

Literature

- Lauber, Göhner: Prozessautomatisierung Bd. 1 u. 2 (Springer)
- John, Tiegelkamp: SPS-Progr. mit IEC 61131-3 (Springer)
- Wellenreuther, Zastrow: Automatisieren m. SPS Theorie u. Praxis (Vieweg)
- B. Baumgarten: Petri-Netze (Spektrum Akad.)
- Priese, Wimmel: Theoretische Informatik - Petri Netze (Springer)

Final exam

Details	Oral examination after written preparation. Based on a natural language description of a realistic automation task of appropriate complexity, the students develop a suitable model for a concurrent event-discrete control system. They justify the essential structures of their model with reference to typical automation system, development and maintenance requirements as well as task-specific specifications and prove that the model shows the required behaviour and quality, can be implemented on a controller device and can then be used as a control system that solves the given automation task.

Minimum standard	- Students extract the essential relevant information and solution limitations from the task specification and develop a reasonable petri net model of a control system using discrete signals and events of the technical process (signal interpreted petri net), taking into account essential automation quality criteria. - Students are able to simulate essential model sections in thought experiments and thus prove that the model under consideration meets special, required behavioral elements. - Students are able to describe and justify an appropriate implementation concept for their specific model on an industrial control device in its essential structures and properties. They show how the individual model elements and structures are mapped to the implementation concept.
Exam Type	EN mündliche Prüfung, strukturierte Befragung

− Lecture / Exercises

Learning goals

Goal type	Description
Knowledge	modelling structure system borders system decomposition system interfaces system functionality behavior state charts (SC) hybrid nets concurrency hierarchy and history concept of actions petri nets place/transition nets (P/T) net elements incidence matrix forward matrix backward matrix condition/event nets (C/E) behavioral analysis firing sequences reachability graph coverability graph (option) invariants (option) net properties assessment liveness reversibility boundedness determinism signal interpreted petri nets (SIPN) modeling pattern complementary place / reservation arcs test arc inhibitor arc event arc (option) hierarchy timed transitions transition subnets place subnets concept of pages calculated arc weight
Knowledge	control system signal processing realtime types sources of time conditions discretization value axis time axis sensors structure of sensor systems with

Special requirements

keine

Accompanying material	presentation slides of the lectures, available digitally, training tasks available digitally, integrated development environment for petri nets, self-study tutorials available digitally lecture notes help sheets videos
Separate exam	No

respect to signal processing
calibration (option)
actuators
structure of actuator systems with respect to signal processing
controller devices
IPC
program organization
resources
RTOS
tasks and threads
scheduling
device categories
µC-Boards
process computer
PAC
RTU
PLC
EN61131
configuration
resources
cyclic tasks
IO variables
program organization
POU
data types
function blocks
programming languages
overview
procedural languages (ST)
graphical languages (FB)
pattern driven realization of SIPN on PLC
examples of controller devices
distributed automation systems
communication
structures
star
bus
ring
redundancy
methods
shared memory
message passing
asynchronous
synchronous
rendezvous
futures
OSI model
protocol layers
MAC
deterministic
non deterministic
field busses
industrial (EN61158)
Interbus
Profibus
Profinet
automotive (option)
CAN
Flexray
area networks
protocol layers

IEEE802
IP
transport protocols
UDP
TCP
SCTP
Industrial Ethernet
hardware
QoS (option)
redundancy (RSTP)
virtual nets (VLAN)
process control systems (PCS, SCADA systems)
EN 61499
architecture
programming
safety
device related safety
network related safety
MES and ERP (option)
object tracking (option)
automatic object identification (AutoID)
object history
protocols

Skills	modeling event driven systems (behavior) derive system behaviour from comprehensive technical documents capture any essential information out of technical documents recognize implicit information identify and resolve missing information model as state chart recognize finite state chart (FSC) as special form signal interpreted net (SIN) model as petri net CE net PT net know syntax consistently and constructively use pattern and makros hierarchical nets use deep hierarchy use flat hierarchy signal interpreted net (SIN) consistently and constructively use petri net development tools verify models define suitable criteria equivalence completeness determinism liveness reversibility boundedness meet given modeling assumptions ... define test cases conduct model reviews by own with peer graphical analysis mathematical analysis conduct dynamic tests using model simulator correct and optimize models based on review and test results

Skills	control system design real time aspects derive real time conditions choose control devices choose bus systems show real time capabilities of control systems programming PLC with ST (EN61131-3) use ST programming syntax use function blocks model driven development design coding templates (pattern) to transform SIPN models into PLC design code generator to transform SIPN models into PLC based on C/E nets based on P/T nets modeling control flows in a PCS (EN61499)

Expenditure classroom teaching

Type	Attendance (h/Wk.)
Lecture	2
Exercises (whole course)	1
Exercises (shared course)	0
Tutorial (voluntary)	1

− Lecture / Exercises

Learning goals

Goal type	Description
Skills	programming control systems consistently and constructively use professional PLC-IDE configure essential attributes of a PLC device consistently use ST programming language use synchronous message passing constructively use function blocks in programs
Skills	use target simulator in interaction with PLC IDE
Skills	manage complex tasks as a team plan and control small projects meet agreements and deadlines plan and conduct reviews
Skills	modelling real world systems system analysis derive system structure and system behaviour from comprehensive technical documents evaluate and take account of system borders and system interfaces decompose system structure define useful subsystems define subsystem functions define subsystem interfaces develop controller model design hierarchical controller model model controller subsystems as SIPN verify and evaluate controller subsystem models conduct dynamic test using petri net simulator conduct peer review integrate controller subsystem models verify and evaluate controller model using petri net simulator

Special requirements

keine

Accompanying material	project task (specification sheet including design input requirements), provided digitally, modelling tools for petri nets and a professional development tool for PLC programming, tutorials (script, video) target system emulator for the target system implementation framework for PLC
Separate exam	Yes

Separate exam

Exam Type	EN Projektaufgabe im Team bearbeiten (z.B. im Praktikum)
Details	attendance phase with 3 times of 4h of presence per project group, final presentation
Minimum standard	Finding suitable system boundaries and modelling a hierarchical control system and the planned subsystems. Control system implementation on a professional controller device.

Skills	program PLC controller configure PLC define cyclic tasks use given IO-variables use given user interface use model transformations transform controller subsystem models into ST programs using transformation pattern integrate controller subsystem programs on PLC verify controller program on PLC test subsystems using target system emulator conduct integration test using target system emulator
Skills	launch controller on target system

Expenditure classroom teaching

Type	Attendance (h/Wk.)
Project	1
Tutorial (voluntary)	0