ADSE3003: DESIGN AND ANALYSIS OF MANUFACTURING PROCESSES AND SYSTEMS

Effective Term
Semester A 2023/24

Part I Course Overview

Course Title
Design and Analysis of Manufacturing Processes and Systems

Subject Code
ADSE - Advanced Design and System Engineering
Course Number
3003

Academic Unit
Systems Engineering (SYE)

College/School
College of Engineering (EG)

Course Duration
One Semester

Credit Units
3

Level
B1, B2, B3, B4 - Bachelor's Degree

Medium of Instruction
English

Medium of Assessment
English

Prerequisites
MA1201 Calculus & Basic Linear Algebra II or MA1301 Enhanced Calculus and Linear Algebra II

Precursors
ADSE2100 Engineering Statistics and Experimentation

Equivalent Courses
Nil

Exclusive Courses
Nil

Part II Course Details

Abstract

A manufacturing system refers to any system that processes resources (e.g. capital, materials, human skills and knowledge) in order to generate products. This course aims to equip students with the necessary skills for analyzing and improving manufacturing systems and their processes. A foundational emphasis will be on determining the relations and tradeoffs among key performance measures such as throughput, inventory level, service level and cycle time in a manufacturing system, based on the Little's Law and queuing theory. This foundation will be applied towards the development of a pull planning framework for the design of manufacturing systems and processes.

Course Intended Learning Outcomes (CILOs)

	CILOs	Weighting (if app.)	DEC-A1	DEC-A2	DEC-A3
1	Describe the basic concepts of a manufacturing system including: workstation, job, throughput, routing, inventory, work-in-process (WIP), cycle time, utilization, bottleneck rate, service level.	10			
2	Apply the Little's Law to analyze relations among cycle time (flow time), throughput (flow rate), work-in-process, capacity, and service level under various conditions.	22			
3	Apply the Little's Law and basic queuing theory to analyze and improve variability in a manufacturing line.	22			
4	Analyze and improve pull production systems in terms of work-in-process, cycle time variability, and analyze the relation between operations and quality of a production system.	23	x		
5	Develop a pull planning framework for the design of manufacturing systems and processes, based on the concepts developed in CILOs 1-4. Perform process re-engineering and improvement, based on the concepts developed in CILOs 1-4.	23	x	x	

A1: Attitude
Develop an attitude of discovery/innovation/creativity, as demonstrated by students possessing a strong sense of curiosity, asking questions actively, challenging assumptions or engaging in inquiry together with teachers.

A2: Ability
Develop the ability/skill needed to discover/innovate/create, as demonstrated by students possessing critical thinking skills to assess ideas, acquiring research skills, synthesizing knowledge across disciplines or applying academic knowledge to self-life problems.

A3: Accomplishments
Demonstrate accomplishment of discovery/innovation/creativity through producing /constructing creative works/new artefacts, effective solutions to real-life problems or new processes.

Teaching and Learning Activities (TLAs)

	TLAs	Brief Description	CILO No.	Hours/week (if applicable)
1	Lectures and in-class discussions	Lectures, in-class exercises, in-class Q&A and discussions will be used to implement CILOs 1-5.	1, 2, 3, 4, 5	39 hours/semester

2	Computer laboratories	In these computer laboratories, students implement the techniques discussed in CILOs 1-5 via open-source software platforms.	1, 2, 3, 4, 5	4 laboratory sessions × 3 hours/session = 12 hours per semester

Assessment Tasks / Activities (ATs)

	ATs	CILO No.	Weighting (%)	Remarks
1	Homework sets, Test, Laboratories exercises	1, 2, 3, 4, 5	50	

Continuous Assessment (%)

50

Examination (%)

50

Examination Duration (Hours)

2

Additional Information for ATs

For a student to pass the course, at least 30% of the maximum mark for the examination should be obtained.

Assessment Rubrics (AR)

Assessment Task

Homework sets, Test, Laboratories exercises

Criterion

Submitted written work

Excellent (A+, A, A-)

For all 5 CILOs, strong evidence of original thinking; good organization, capacity to analyse and synthesize; superior grasp of subject matter; evidence of extensive knowledge base.

Good (B+, B, B-)

For at least 4 out of 5 CILOs, evidence of grasp of subject, some evidence of critical capacity and analytic ability; reasonable understanding of issues; evidence of familiarity with literature.

Fair (C+, C, C-)

For at least 4 out of the 5 CILOs, evidence that student is profiting from the university experience; understanding of the subject; ability to develop solutions to simple problems in the material

Marginal (D)

For at least 4 out of the 5 CILOs, sufficient familiarity with the subject matter to enable the student to progress without repeating the course.

Failure (F)

Little evidence of familiarity with the subject matter; weakness in critical and analytic skills; limited, or irrelevant use of literature.

Assessment Task

Examination

Criterion

Submitted written work

Excellent (A+, A, A-)

For all 5 CILOs, strong evidence of original thinking; good organization, capacity to analyse and synthesize; superior grasp of subject matter; evidence of extensive knowledge base.

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Part III Other Information

Keyword Syllabus

- Basic concepts of a production/service system: workstation, job, throughput/flow rate, routing, inventory, work-in-process (WIP), cycle time/flow time, utilization, bottleneck rate, capacity, service level;
- Little's Law for expressing the relation between inventory level, cycle time, utilization and service level;
- Basic queuing theory: e.g. M/M/1, M/M/1/b, G/G/1, G/G/m;
- Process time variability, flow variability and variability interactions;
- Variability improvement based on buffering, batching, increasing bottleneck utilization and reducing cycle time.
- Description of pull production/service systems using the Little's Law and basic queuing theory. Relation between operations and quality in a production/service system via the Little's Law and basic queuing theory.
- A pull planning framework for the design of manufacturing systems and processes. Process re-engineering and improvement.

Reading List

Compulsory Readings

	Title
1	Lecture notes and slides provided by the instructor

Additional Readings

	Title
1	Factory Physics, 3rd Edition, Wallace Hopp and Mark Spearman, Waveland Press, 2011.
2	Manufacturing Systems Modeling and Analysis, 2nd Edition, Curry and Feldman, Springer-Verlag, 2011.
3	Automation, Production Systems, and Computer-Integrated Manufacturing, 5th Edition, Mikell Groover, Pearson, 2018.