Course 11: Collaborative Manufacturing Systems (2-0-3)

Course Objective: Collaboration among partners to form a value network has become necessary as up-to-date information is so critical in a competitive market. Sharing of information among a network of physical units on the shop floor and connecting internal manufacturing processes and business processes with external business processes allow a company to offer a core competence with flexible, responsive operations meeting the expectations of customers and the value network partners. This course aims to build students' competence in collaboration in manufacturing from the board picture of collaborative manufacturing management down to collaboration on a shop floor. The students will learn from concepts, applications, and hands-on experience.

Learning Outcomes:

The students on the completion of this course would be able to:

CLO1. Recognize a potential collaborative manufacturing in a factory (understand)
CLO2. Identify a value network for collaborative manufacturing for a business (apply)
CLO3. Apply collaborative manufacturing management in practice (apply)
CLO4. Manipulate collaborative robots for collaborative tasks (apply)
CLO5. Manage manufacturing collaboration on a shop floor (apply)

Prerequisite: none

Course Outline:

Module I Collaborative Manufacturing Management

1. Evolution of Manufacturing Systems
2. Collaborative Manufacturing Management Model
3. Collaborative Manufacturing Management Fundamentals and Infrastructure
4. Ontology for Collaborative Manufacturing

Module II Machines Collaboration on a Shop Floor

1. Distributed Manufacturing
2. Distributed Arrival Time Control for Real-Time Scheduling
3. Collaborative Material Handling System
4. Collaborative Manufacturing Processes

Module III Man-Machine Collaboration on a Shop Floor

1. Evolution of Man-Machine Collaboration
2. Industrial human augmentation systems
3. Flexible Human-Robot Collaboration
4. Cyber-Human System

Workshop Sessions:

Laboratory Sessions:

- Laboratory on plant simulation: Simulate a manufacturing process based on local industries, identify a value network for collaborative manufacturing and apply collaborative manufacturing management.
- Laboratory on collaborative machines: Manipulate co

Learning Resources:

Textbooks: No designated textbook, but class notes and handouts will be provided.

Reference Books:

1. Andre P. Calitz, Paul Poisat and Margaret Cullen, 2017, The future African workplace: The use of collaborative robots in manufacturing, SA Journal of Human Resource Management,pp. 1-11.

2. ARC Advisory group, 2001, Collaborative Manufacturing Management Strategies, ARCweb.com, pp.1-28

3. Eloise Matheson, Riccardo Minto, Emanuele G. G. Zampieri, Maurizio Faccio and Giulio Rosati, 2019, Human–Robot Collaboration in Manufacturing Applications: A Review, Robotics, Vol.8(100), pp. 1-25

4. Koomsap, P., Shaikh, I., Prabhu, V.V., 2005, Integrated process control and condition-based maintenance scheduler for distributed manufacturing control system, International Journal of Production Research, Vol. 43, No. 8, pp. 1625-1624.

5. Li, W. D., Ong, S. K., Nee, A. Y.C., McMahon, C. A. (Eds.), 2007, Collaborative Product design and manufacturing methodologies and applications. Springer Science & Business Media.

6. Luis M. Camarinha-Matos , Rosanna Fornasiero and Hamideh Afsarmanesh, 2017, Collaborative Networks as a Core Enabler of Industry 4.0 in Collaboration in a Data-Rich World. PRO-VE 2017. IFIP Advances in Information and Communication Technology, vol 506, pp 3-17.

7. Matthew Krugh and Laine Mears, 2018, A complementary Cyber-Human Systems framework for Industry 4.0 Cyber-Physical Systems, Manufacturing Letters, vol 15, pp. 89-92.

8. Melo, J. G., Fattori, C. C., Junqueira, F., & Miyagi, P. E., 2009,. Framework for collaborative manufacturing systems based in services. 20th International Congress of Mechanical Engineering (COBEM), Gramado, Brazil.

9. Mohammad Rizal Firmansyah and Yousef Amer, 2013, A Review of Collaborative Manufacturing Network Models, International Journal of Materials, Mechanics and Manufacturing, Vol. 1, No.1 pp. 6-12.

10. Roope Raisamo, Ismo Rakkolainen, Päivi Majaranta, Katri Salminen, Jussi Rantala and Ahmed Farooq, 2019, Human augmentation: Past, present and future, International Journal of Human-Computer Studies, Vol. 131, pp. 131-143.

11. Shirine El Zaatari, Mohamed Marei, Weidong Li and Zahid Usman, 2019, Cobot programming for collaborative industrial tasks: An overview, Robotics and Autonomous Systems, Vol. 116, pp.162–180.

12. Wit Grzesik, Hybrid additive and subtractive manufacturing processes and systems: A review (2018), Journal of Machine Engineering, Vol. 18, No. 4, pp. 5–24.

Journals and Magazines:

Journal of Machine Engineering

Robotics and Autonomous Systems

International Journal of Human-Computer Studies

International Journal of Materials, Mechanics and Manufacturing

Manufacturing Letters

Teaching and Learning Methods: Each major topic of this course is approached using a three steps process: lecture together with class discussion and in-class group assignments, including case studies and practical exercises that students will work on and present at the end of the sessions. The students are expected to involve actively in-class activities. The students will also apply knowledge learned from class in laboratory sessions, which have been designed to match the learning topics. Besides, there will be a group project for the students to practice their knowledge, critical thinking, problem-solving, and decision-making skills as well as team management.

Time Distribution and Study Load:

Lectures:	30 hours
Laboratory sessions:	45 hours
Self-study/Projects:	45 hours

Evaluation Scheme: The final grade will be computed according to the following weight distribution:

Class discussion and participation 5%, Peer assessment in class activities 5%, Assignments 10%

Practical exercises 20%, Presentation 10% and Group project 50%.

The mark ("A", "B" ... 1 - 10) obtained by student will be given according to the rules of each university, based on the total number of points accumulated.

An "A" would be awarded if a student shows a deep understanding of the knowledge learned through assignments, project works, and exam results.

A "B" would be awarded if a student shows an overall understanding of all topics.

A "C" would be given if a student meets below average expectation in understanding and application of basic knowledge.

A "D" would be given if a student does not meet expectations in both understanding and application of the given knowledge.

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