
Jindal Global Business School
Course Outline

Course Title	Operations of Modern Industrial Ecology
Core or Elective	Elective
Program and Batch	IBM 4 & 5, MBA-2
Semester & Academic Year	Fall 2025
Credits	1.5
Discipline/Area	Operations Management & Supply chain
Provide details if this course is a Prerequisite for any course/specialization	NA
Name of the Faculty Member/Course Instructor	Vinayak A Drave
Contact Details of the Faculty Member	vadrave@jgu.edu.in
Contact Details of Support Staff	jgbs-co@jgu.edu.in
Faculty Member's Open Office Day/s & Time	Tuesday 3-4 pm Thursday 3-4 pm

Introduction to the Course

This course provides a systems-based understanding of **Industrial Ecology (IE)** and its operational relevance in the modern business ecosystem. Students will explore the foundational concepts of IE and its evolving application in manufacturing and services, with an emphasis on resource efficiency, waste valorization, circular economy, and systemic thinking. By analyzing clusters, economic considerations, and practical constraints, the course aims to build capacity for future managers to integrate industrial ecology into strategic operations and sustainability goals.

Course Learning Objectives

At the end of the course, students should be able to

1. CLO1 – Understand and articulate the foundational principles of industrial ecology and its relevance to modern operations.
2. CLO2 – Analyze the roles of ecological principles in manufacturing and service sector operations.
3. CLO3 – Evaluate the structural role of clusters and inter-organizational networks in industrial ecology.
4. CLO4 – Understand operational strategies integrating ecological considerations to address real-world challenges.

Programme Competency Goals

MBA Programme Competency Goals (PCGs)		MBA Programme Learning Objectives (PLOs)
		Students will be able to
1	Technological Agility: Ability to adopt relevant technologies for better business decision making.	1. Understand relevant business technologies
		2. Understand future technologies in business domain
2	Responsible Global Citizenship: Ability to understand the interplay between local and global issues and to act with sensitivity towards ethical and social issues	3. Understand the interplay between local and global business issues
		4. Demonstrate sensitivity towards ethical issues
		5. Demonstrate sensitivity towards social issues
		6. Address societal issues
3	Effective communication: Ability to effectively exchange ideas and information	7. Present their ideas with clarity
		8. Prepare an organized and logical business document
		9. Use technology for effective communication
4	Critical Thinking: Ability to identify, analyze business problems and propose effective solutions	10. Identify main issues of business problems
		11. Examine information from different sources
		12. Draw inferences from analysis
		13. Evaluate alternatives
		14. Summarize and conclude
5	Leadership: Ability to take initiative, inspire and collaborate with others	15. Take initiative
		16. Contribute effectively in groups
6	Discipline Knowledge: Ability to apply business analytics knowledge to diverse business situations	17. Create analytics model/s to address business problems
		18. Apply analytics model/s to find solutions to address business problems
		19. Draw actionable insights from analytics model/s

PLO-PCG Assessments Mapping Matrix

Program Learning Objectives (PLOs)	Program Competency Goals (PCGs)	Course Assessment Item
This course helps you to develop the following Program Learning Outcomes:	This course helps you to develop the following Program Competency Goals:	This learning outcome will be assessed in the following items
PCG2 – PLO4, PLO5, PLO6 PCG3 – PLO7, PLO8 PCG4 – PLO10, PLO11 PCG5 – PLO15, PLO16	PCG2; PCG3; PCG4; PCG5	A1, A2
PCG4 – PLO12, PLO13, PLO14	PCG4	A1, A2, A3, A4
PCG1 – PLO1, PLO2 PCG3 – PLO9	PCG1; PCG3	A1, A2

Evaluation Schema:

The course grade will be determined based on:

Assessment Task	Weightage (Percentage)	Nature (Individual/Group)	Week of Assessment	PLOs to be Assessed
A1: Class Participation	10%	Individual	Continuous	PLO-01, 02, 03, 07 & 10
A2: Quiz 2	20%	Individual	Session-4 & Session 7	PLO-01, 02, 03, 07 & 10
A3: Assignment	20%	Group	Week-4 (Session-8)	PLO-01, 02, 03, 07, 08, 10, 11, 12,13 & 14
A4: Mid term	20%	Induvial	As per the dates decided by the school	PLO-01, 02, 03, 07 & 10
A5: End Term Assessment	30%	Project Presentation at Individual level and viva	As per the dates decided by the University	PLO-01, 02, 03, 07 & 10

Description of Assessments:

A1- Class Participation (10%) - The participation of the students in class discussion, guest lectures, and experiential learning sessions shall be evaluated out of **10 marks**.

A2- Quiz (20%)- We will have two **quizzes for 20 marks during the semester**. The quizzes shall be announced one week in advance, and no requests for re-quiz/ make-up quizzes/ alternate assignments shall be entertained.

A3- Group Assignment (20%) - There will be an **assignment submission** based on the course's learning, which will carry **20 marks**, and the students need to make a **presentation** out of the submitted assignment

A4- *Mid Term Examination (20%) - There will be a pen-paper-based **mid-term examination** of 20 marks. The duration of the mid-term exam will be **90 minutes**.

A5- *End Term Examination (30%) - There will be a pen-paper-based **end-term examination** of 30 marks during the examination week. The duration of the mid-term exam will be at least **180 minutes**.

Rubrics for Assessments

Criteria	Exceeds Expectations	Meets Expectations	Below Expectations
Content	The assignment demonstrates exceptional knowledge and understanding of the subject matter. The content is thorough, well-organized, and insightful.	The assignment demonstrates a good understanding of the subject matter. The content is well-organized and presents relevant information.	The assignment demonstrates limited understanding of the subject matter. The content is disorganized and presents incomplete or inaccurate information.
Analysis	The assignment provides insightful and original analysis of the topic, using relevant examples and evidence to support arguments.	The assignment provides a good analysis of the topic, using some examples and evidence to support arguments.	The assignment provides limited or no analysis of the topic, with little or no use of examples or evidence.
Presentation	The assignment is well-presented, with clear and concise writing, appropriate use of visuals, and effective use of referencing and citation.	The assignment is adequately presented, with clear writing, appropriate use of visuals, and adequate referencing and citation.	The assignment is poorly presented, with unclear writing, inadequate use of visuals, and insufficient referencing and citation.

Research	The assignment demonstrates extensive research, using a variety of high-quality sources to support arguments.	The assignment demonstrates some research, using a mix of sources to support arguments.	The assignment demonstrates limited research, using few or unreliable sources to support arguments.
Overall	The assignment exceeds expectations in all areas and demonstrates exceptional work.	The assignment meets expectations in most areas and demonstrates good work.	The assignment falls short of expectations in most areas and demonstrates inadequate work.

Presentation Rubric

Criteria	Exceeds Expectations	Meets Expectations	Below Expectations
Content	The presentation demonstrates exceptional knowledge and understanding of the subject matter. The content is thorough, well-organized, and insightful.	The presentation demonstrates a good understanding of the subject matter. The content is well-organized and presents relevant information.	The presentation demonstrates limited understanding of the subject matter. The content is disorganized and presents incomplete or inaccurate information.
Delivery	The presentation is engaging and dynamic, with clear and confident delivery, appropriate use of body language, and effective use of visual aids.	The presentation is engaging, with clear delivery, appropriate use of body language, and adequate use of visual aids.	The presentation is dull or unengaging, with unclear delivery, inappropriate use of body language, and insufficient use of visual aids.
Time Management	The presentation is well-timed and covers all relevant topics within the allotted time.	The presentation is adequately timed and covers most relevant topics within the allotted time.	The presentation is poorly timed and fails to cover relevant topics within the allotted time.
Interaction	The presentation encourages interaction and engagement with the audience, using appropriate questioning and responding effectively to audience feedback.	The presentation attempts to engage the audience, but with limited success in encouraging interaction or responding to audience feedback.	The presentation does not attempt to engage the audience or respond to audience feedback.

Teaching Method

The mode of delivery of the course is in class. Thus, the teaching method adopted would be using PPT/slides and discussions and interactive mode of content delivery for helping students understand the key concepts and to drive potential solution. Solving problems would help the students and the application of the concepts learned. The course will also have a class discussion approach with question-and-answer sessions in between.

Textbook / Other Readings

- Graedel, T. E., & Eckelman, M. J. (2023). *Industrial Ecology and Sustainability*. World Scientific
- Shah, A., Ibrahim, A., & Adeel/Che Mat Shah (Che Rosmawati). (2024). *Industrial Ecology*.

Guest Lectures

S. No.	Faculty member(s)	Guest Speakers [Name, designation, and company]	Week # (Tentative)
1	Vinayak A Drave	Siddharth Bajpayee, Lead Engineer, Mercedes, Germany	3

Session Plan

Session Details	Topics	PLOs Covered
Session 1	Foundations of Industrial Ecology	PLO-01, 02, 03, 07 & 10
Objective of the session	Define Industrial Ecology (IE) and explore its foundational principles.	
Subtopics to be covered	Origins of IE, Closed-loop systems	
Readings	https://www.forbes.com/sites/deloitte/2021/06/10/ecosystems-and-smart-manufacturing-amplify-your-investment/	
Case Title & Number	NA	
Pedagogy	Lecture + Case Discussion.	
Session 2	Systems Thinking in Industrial Ecology	PLO-01, 02, 03, 07 & 10
Objective of the session	Understand systems-based thinking in IE.	
Subtopics to be covered	System boundaries, stocks and flows, sustainability metrics	
Readings	NA	
Case Title & Number	Largest Car Factory in the World (Full Episode) Superstructures: Engineering Marvels Nat Geo Available online at https://www.youtube.com/watch?v=NQgal5kteYw&t=1382s&pp=ygUnU3lzdGVtcyBUaGlua2luZyBpbjBJbmR1c3RyaWFsIEVjb2xvZ3kg	
Pedagogy	Lecture + Case Discussion.	
Session 3	The Strategic Importance of Industrial Ecology	PLO-01, 02, 03, 07 & 10
Objective of the session	Identify key drivers and significance of IE in modern operations.	
Subtopics to be covered	Resource scarcity, climate challenges, closed-loop benefits.	
Readings	NA	
Case Title & Number	Building Industry Clusters available online at https://www.youtube.com/watch?v=Nq-hlJfp9Mo	

Pedagogy	Lecture + Case Discussion.	
Session 4	Guest Lecture	PLO-01, 02, 03, 07, 08, 10, 11, 12,13 & 14
Objective of the session	Analyze IE's alignment with ESG and SDG frameworks.	
Subtopics to be covered	SDG 9 and 12, B-Corp IE strategy, social enterprise synergy.	
Readings	NA	
Case Title & Number	How China's Industrial Policy Accelerated Its Green Tech Economy's Growth Available at https://www.youtube.com/watch?v=NoRcP87Lu78&t=83s	
Pedagogy	Online Guest Lecture	
Session 5	Clustering for Ecological Synergy	PLO-01, 02, 03, 07 & 10
Objective of the session	Understand the concept and utility of eco-industrial clusters.	
Subtopics to be covered	Industrial clustering, spatial ecology, cluster theory.	
Readings	NA	
Case Title & Number	Toyota WOVEN CITY Launch – Toyota City Japan Most Futuristic City in the World available online at https://www.youtube.com/watch?v=Kj5ZtzKFIBA	
Pedagogy	Lecture + Case Discussion.	
Session 6	Symbiotic Networks and Clusters	PLO-01, 02, 03, 07, 08, 10, 11, 12,13 & 14
Objective of the session	Evaluate inter-firm collaboration and shared resource networks.	
Subtopics to be covered	Governance models, infrastructure sharing, symbiotic networks.	
Readings	NA	
Case Title & Number	Kalundborg Symbiosis-Denmark available at https://www.youtube.com/watch?v=Ism7NdQe94I	
Pedagogy	Lecture + Case Discussion.	
Session 7	Material Flow Analysis and manufacturing in Industrial Ecology	PLO-01, 02, 03, 07 & 10
Objective of the session	Understand how material and energy flows are quantified and optimized within and across industrial systems.	
Subtopics to be covered	Principles of Material Flow Analysis (MFA) Energy cascading and exergy analysis Industrial metabolism and input-output modeling	
Readings	NA	
Case Title & Number	Taiwan's Bicycle Manufacturing Advantage available online at https://www.youtube.com/watch?v=CjWz-0Zbw0s	
Pedagogy	Lecture + Case Discussion.	

Session 8	Designing Industrial Ecosystems for Circularity	PLO-01, 02, 03, 07, 08, 10, 11, 12,13 & 14
Objective of the session	Understand how industries co-locate and share resources to mimic ecological cycles.	
Subtopics to be covered	Industrial ecosystem design, spatial integration, shared utilities, reverse logistics within IE.	
Readings	NA	
Case Title & Number	From Rooftop Solar to Shared Power in Sweden's First Energy Community available online at https://www.youtube.com/watch?v=SFxZuYin7UQ	
Pedagogy	Lecture + Case Discussion.	
Session 9	Service Ecosystems and Industrial Ecology	PLO-01, 02, 03, 07 & 10
Objective of the session	Explore how service-dominant operations integrate into broader industrial ecosystems through shared platforms and collaborative models.	
Subtopics to be covered	Role of services in enabling resource sharing (mobility, logistics, energy-as-a-service) Product-Service Systems (PSS) in circular ecosystems Decentralized services and industrial symbiosis Service layers in industrial clusters	
Readings	NA	
Case Title & Number	The power of ecosystems available online at https://www.youtube.com/watch?v=5yUpfrNZGrY	
Pedagogy	Lecture + Case Discussion.	
Session 10	Information Systems and Digital Infrastructure in Industrial Ecology	PLO-01, 02, 03, 07 & 10
Objective of the session	Understand how digital tools and information systems facilitate system integration, feedback loops, and resource efficiency in industrial ecology.	
Subtopics to be covered	Role of digital twins, IoT, and blockchain in IE Monitoring resource exchanges and industrial emissions	
Readings	NA	
Case Title & Number	Catalyzing the Green Digital Transformation (World bank) available at https://www.youtube.com/watch?v=SNVcipV3hqC	
Pedagogy	Lecture + Case Discussion.	
Session 11	Barriers to Industrial Ecology Implementation	PLO-01, 02, 03, 07 & 10
Objective of the session	Identify and critically assess implementation challenges.	
Subtopics to be covered	Data gaps, fragmented regulations, stakeholder resistance.	
Readings	NA	
Case Title & Number	Why SEZs Couldn't Make India The Manufacturing Powerhouse? Available online at https://www.youtube.com/watch?v=K7ikyMyuwUA	

Pedagogy	Lecture + Case Discussion.	
Session 12	Organizational Resistance and Legacy Systems	PLO-01, 02, 03, 07, 08, 10, 11, 12,13 & 14
Objective of the session	Understand barriers from legacy operations and change resistance.	
Subtopics to be covered	Behavioral inertia, transition costs, change leadership.	
Readings	NA	
Case Title & Number	Then & Now: India versus China available at https://www.youtube.com/watch?v=t4D8l2RByTs	
Pedagogy	Lecture + Case Discussion.	
Session 13	Economic Analysis of Industrial Ecology	PLO-01, 02, 03, 07, 08, 10, 11, 12,13 & 14
Objective of the session	Explore ROI, cost savings, and shared resource efficiencies.	
Subtopics to be covered	Cost-benefit models, remanufacturing economics, triple bottom line.	
Readings	NA	
Case Title & Number	Reducing the Impact of Production - Factory Tomorrow, available online at https://www.youtube.com/watch?v=3q_rKswyFtE	
Pedagogy	Lecture + Case Discussion.	
Session 14	Measuring Success in Industrial Ecology	PLO-01, 02, 03, 07 & 10
Objective of the session	Understand how to assess the performance of industrial ecology initiatives using systemic indicators.	
Subtopics to be covered	Key metrics: resource efficiency, Quantitative vs. qualitative indicators	
Readings	NA	
Case Title & Number	Cluster-based Industrial Transition in Piedmont, European Cluster Collaboration Platform available online at https://www.youtube.com/watch?v=FHuJ_FZKp8	
Pedagogy	Lecture + Case Discussion.	
Session 15	Future of Industrial Ecology	PLO-01, 02, 03, 07, 08, 10, 11, 12,13 & 14
Objective of the session	Synthesize learning and propose strategic frameworks for embedding industrial ecology into national, regional, and corporate policies.	
Subtopics to be covered	Policy tools supporting industrial ecology (e.g., fiscal incentives, regulations, innovation subsidies) Roadmaps and action plans: global, national, and corporate perspectives	
Readings	NA	
Case Title & Number	Why Chinese Manufacturing Wins available online at https://www.youtube.com/watch?v=u-RRO6fD-BY	
Pedagogy	Lecture + Case Discussion.	

NOTE:

1. Please note that the session plan(s) may be modified partially/fully to suit the requirements of the learners. The instructor/faculty will have the sole discretion to modify session plan(s) as and when required.
2. In case of unavailability of the guest speaker in the planned sessions, the session plan(s) might be modified.

Disability Support

JGU endeavours to make all its courses accessible to students. The Disability Support Committee (DSC) has identified conditions that could hinder a student's overall wellbeing. These include physical and mobility-related difficulties, visual impairment, hearing impairment, mental health conditions, and intellectual/learning difficulties, e.g., dyslexia and dyscalculia. Students with any known disability needing academic and other support are required to register with the Disability Support Committee (DSC) by following the procedure specified at <https://jgu.edu.in/disability-support-committee/>

Students who need support may register any time during the semester up until a month before the end semester exam begins. Those students who wish to continue receiving support from the previous semester, must re-register within the first month of a semester. Last-minute registrations and support might not be possible as sufficient time is required to make the arrangements for support.

The DSC maintains strict confidentiality about the identity of the student and the nature of their disability and the same is requested from faculty members and staff as well. The DSC takes a strong stance against in-class and out-of-class references made about a student's disability without their consent and disrespectful comments referring to a student's disability.

All general queries are to be addressed to disabilitysupportcommittee@jgu.edu.in