Systems Thinking for Design

Session 1

https://sites.google.com/a/iiitdm.ac.in/sudhirvs/courses/systems-thinking-for-design

INDIAN INSTITUTE OF INFORMATION TECHNOLOGY, DESIGN AND MANUFACTURING, KANCHEEPURAM

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- Member, CII-SR-MADE Committee

Introductory Session

IIITDM: Engineering, Design, Entrepreneurship

DES201T: Learning Objectives & Course Structure

Exercise 1.1: What do these terms mean to you? (10 min)

1. Science (Natural / Social)
2. Engineering
3. Technology
4. Innovation
5. Entrepreneurship
6. Management
7. Enterprise/Business
8. Industry

Make-in-India

Startup India

Skill India

IIITDM

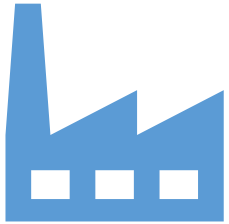
9. Product Design
10. Industrial Design
11. Engineering Design
12. Prototype
13. Manufacturing
14. User
15. Customer
16. Market

Constraint: Should not exceed a page & should include all terms

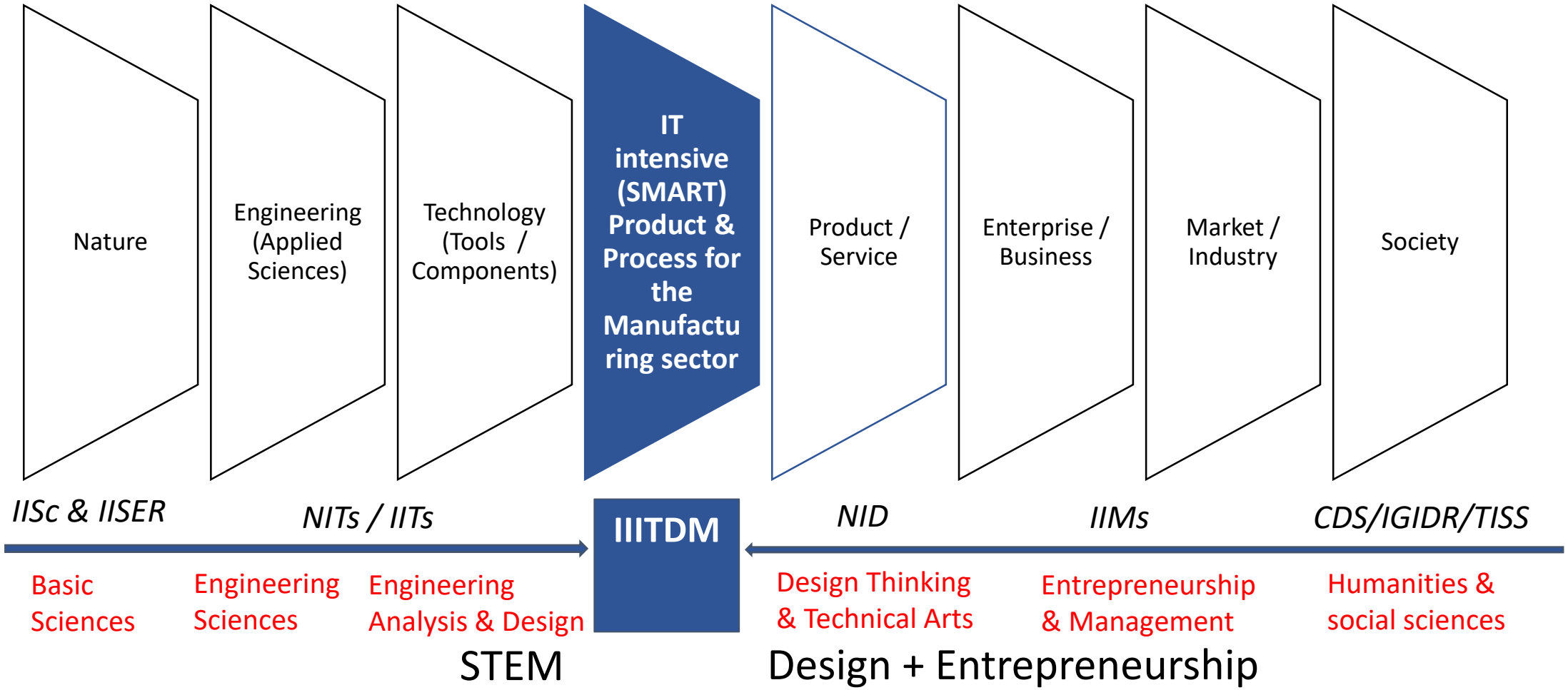
National Priority: Make-in-India & Manufacturing

- Phase-1 of Make-in-India happened with the Indian IT industry, 1995-2005 and laid the foundation for a digital ecosystem

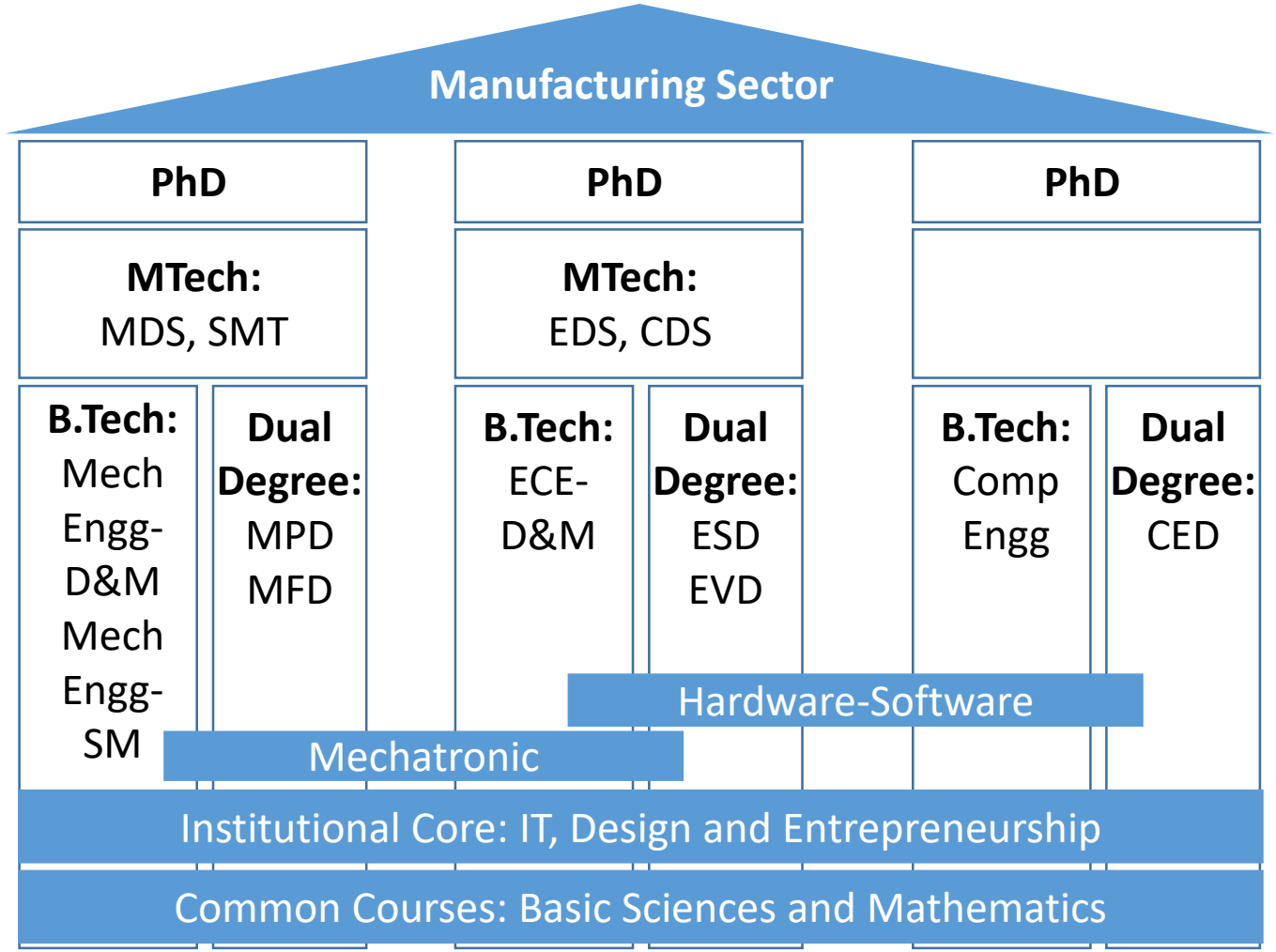
- Phase-2 is the focus on increasing the **manufacturing sector** contribution to 25% of the GDP leveraging the digital ecosystem
  - **Leveraging Industry 4.0 (Smart and Advanced Manufacturing)**
    - CII-SR Initiative: Manufacturing and Digital Excellence (MADE)
    - Digital disruption at the shop floor & in capital goods
    - Importance of Design
    - IIOT and integration
  - **Startup India (Entrepreneurship & Job creation in the SME sector)**
  - **Skill India**



IIITDM: Conceptualized in 2003 and setup in 2007 to develop a new engineer for the manufacturing sector



16 industry-focused and inter-disciplinary academic programs



Automotive, Engineering Goods, Space, Medical Devices, Consumer Products

Focused on disciplines critical for engineering Cyber-Physical Systems:

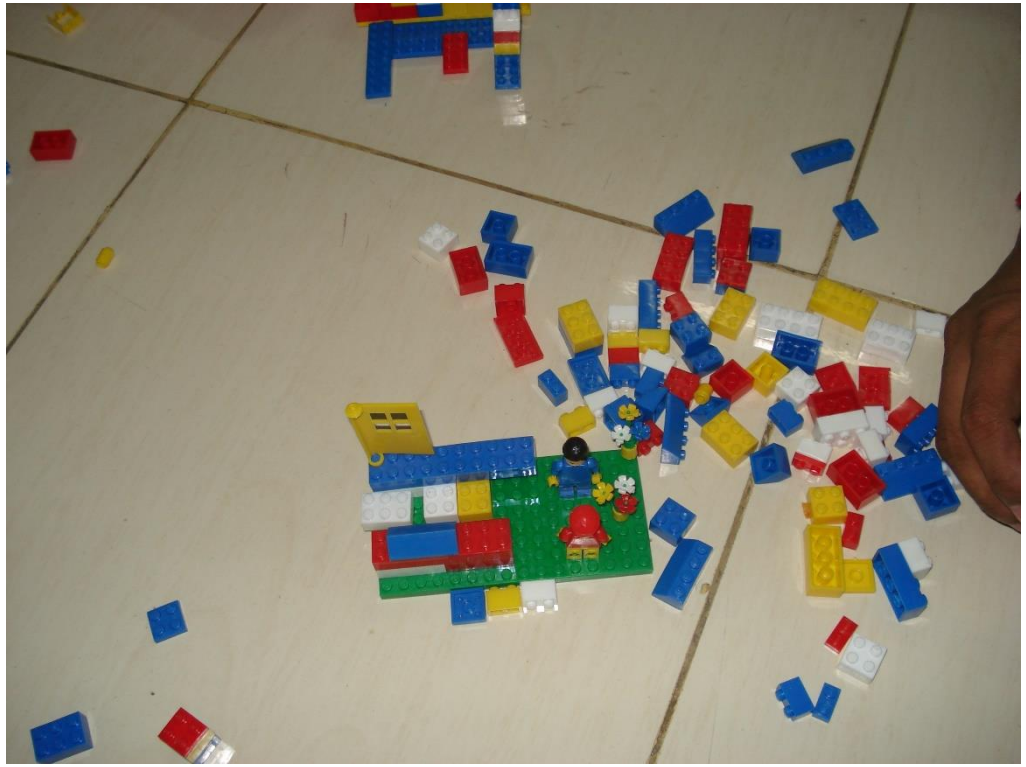
- ***Computer Science & Engg***
- ***Electronics & Comm Engg***
- ***Mechanical Engineering***

Grounded in Design Thinking and Inter-disciplinary approach with emphasis on learning-by-doing

1200+ students on campus

45 faculty with a plan to expand to 100+ in next 2 years

Exercise 1.2 (10 min): What competencies did you develop in Year-1 & how?



Relook at your first year courses and depict using the skills you have acquired in the first year

My assumption: all of you remember the courses

Course No	Course Name
MAT104T	Calculus
PHY107T	Engineering Electromagnetics
ELE103T	Basic Electrical & Electronics Engineering
DES101T	Concepts in Engineering Design /
INT107T	English for Communication
MAN102T	Professional Ethics
INT110P	Engineering Skills Practice
INT111P	Measurement & Data Analysis lab
PHY107P	Engineering Electromagnetics Practice
INT109P	Engineering Graphics

Course No	Course Name
MAT105T	Differential Equations
PHY108T	Engineering Mechanics
INT108T	Science and Engineering of Materials
COM105T	Computational Engineering /
DES102T	Design History
DES103T	Earth, Environment & Design
PHY109P	Basic Materials & Mechanics Practice
COM105P	Computational Engineering Lab
DES104P	Industrial Design Sketching
DES105P	Design Realization

The answer that is most common will receive lowest marks

The ever rising gap between engineering students' competence & industry expectations

- Knowledge
- ***Skills/Know-how***
- ***Attributes/Behaviors***

Industry Expectations

- Productivity from day-1
- Contribute to innovation
- Help build a new culture

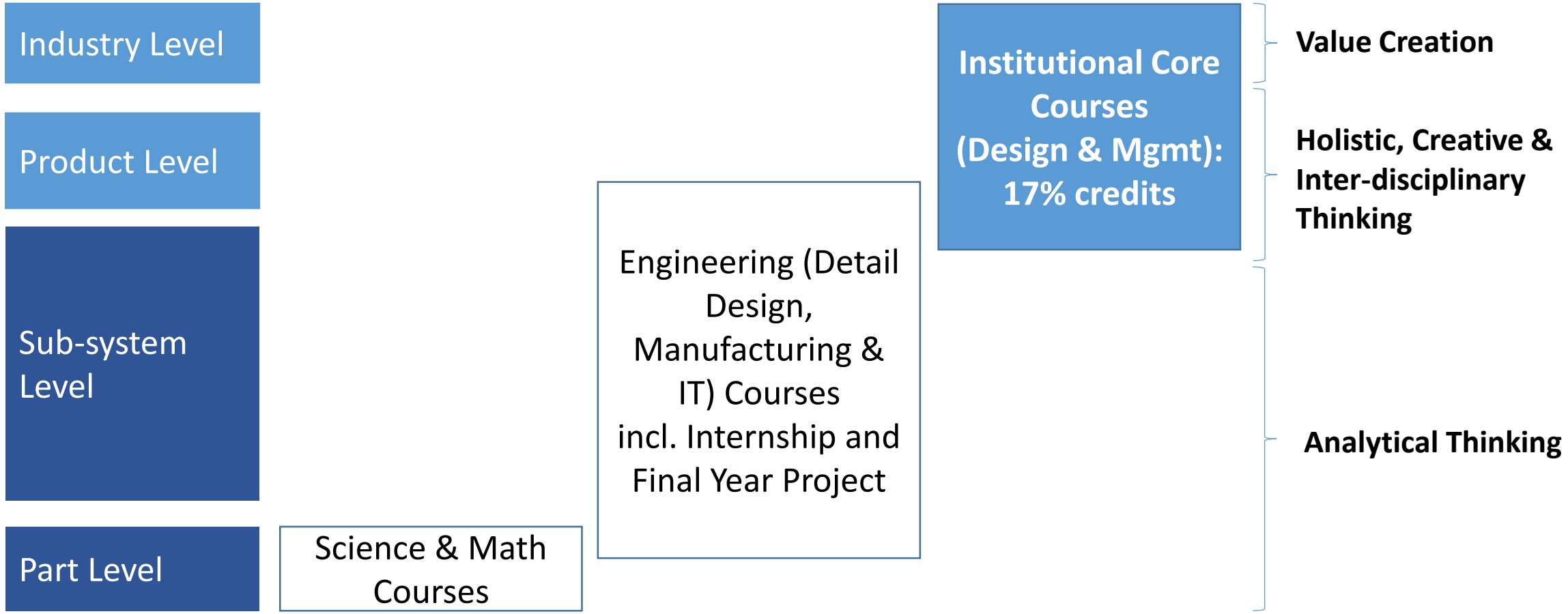
Key Attributes for Engineer 2020 (NAE, USA)

Analytical Skills	Practical Ingenuity	Creativity	Communication & Teamwork
Business, Management, Leadership	Ethics & Professionalism	Agility, Resilience, Flexibility	Lifelong Learning

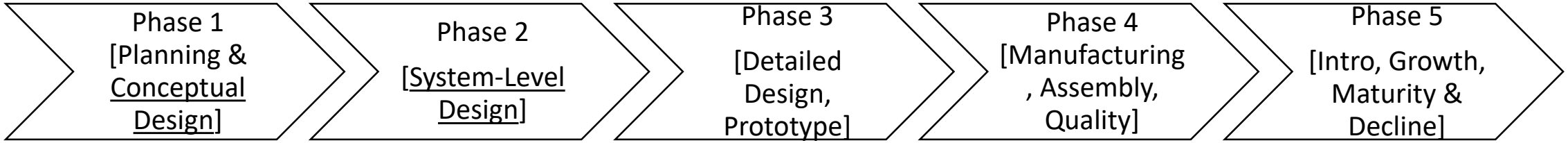
How can one develop these attributes?

Experiments in the US (Olin), Europe (Atlas) and China

Product design & entrepreneurship are at a different level compared to engineering & science



Breadth and depth offered to an engineer to increase future choices



83% Credits

ENGINEERING (DETAIL DESIGN & MANUFACTURING) [PEC]
Engineering Sciences (Materials, Energy, Information) [BEC]
Basic Sciences (Maths, Physics) [BSC]
Electives (Online / Professional / Inter-disciplinary)

IT: Programming, DSA, Analysis/Simul, Design & Verification Tools

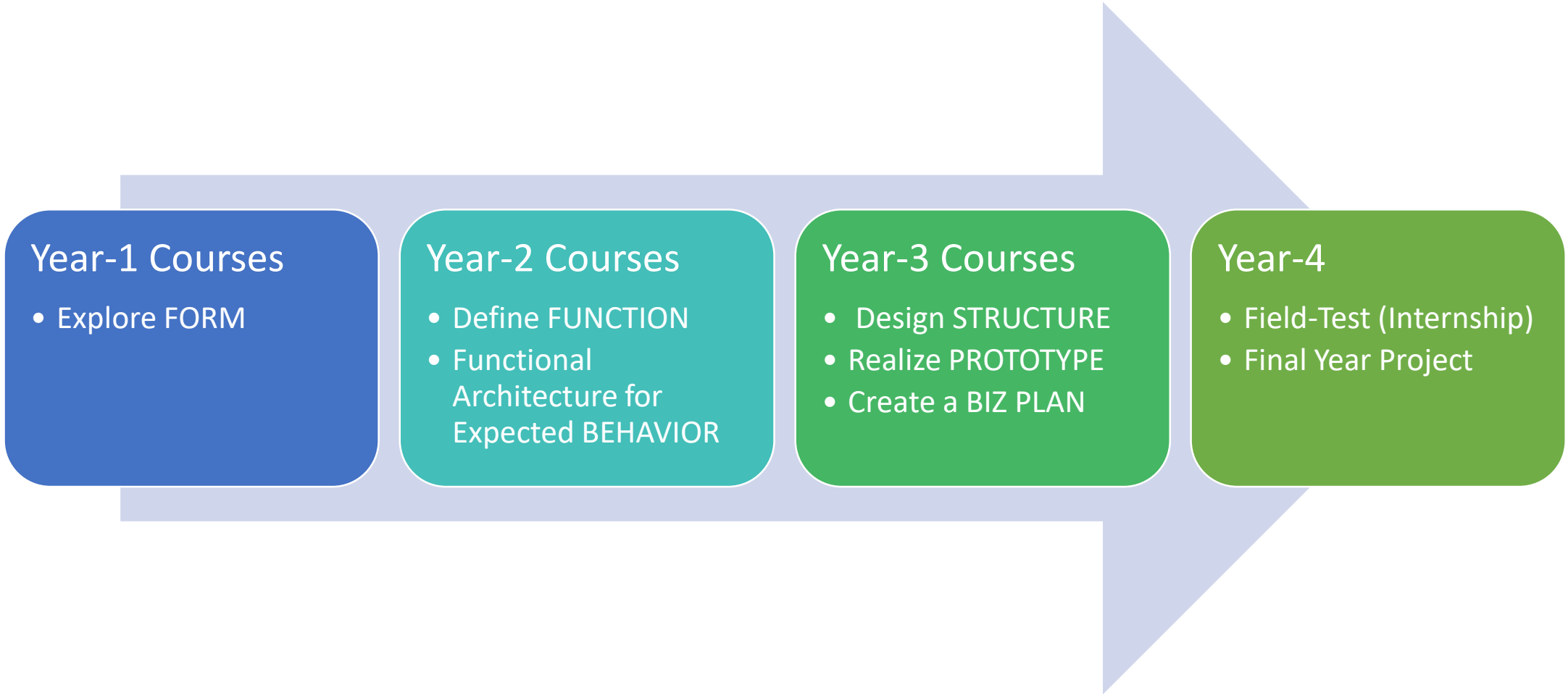
Practical Work (Internship, Final Year Project) [PCD]

17%

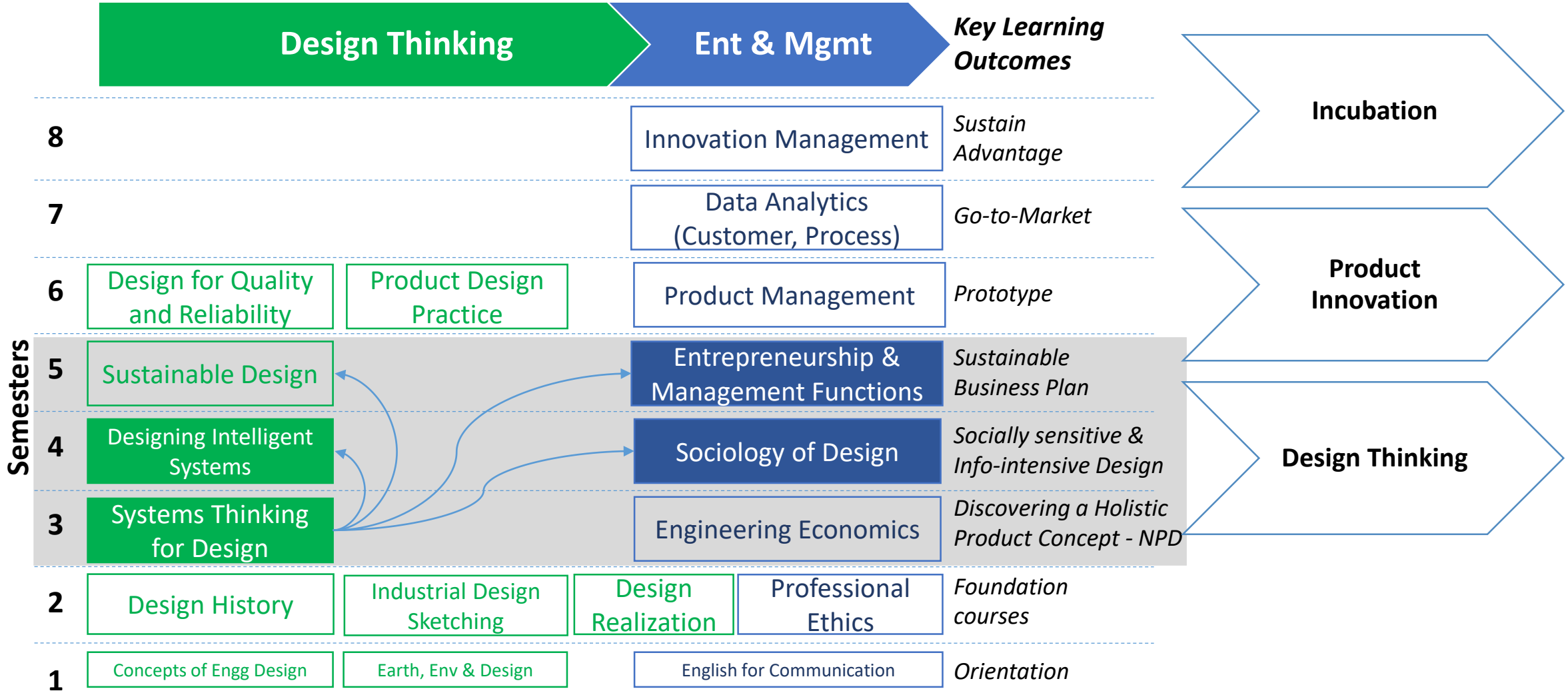
INTER-DISCIPLINARY PRODUCT DESIGN [ICC]
Sciences of the Artificial, Semiotics & HSS

ENTRREPRENEURSHIP & MANAGEMENT PRINCIPLES [ICC]
Humanities & Social Sciences (Art, History, Economics, Sociology)

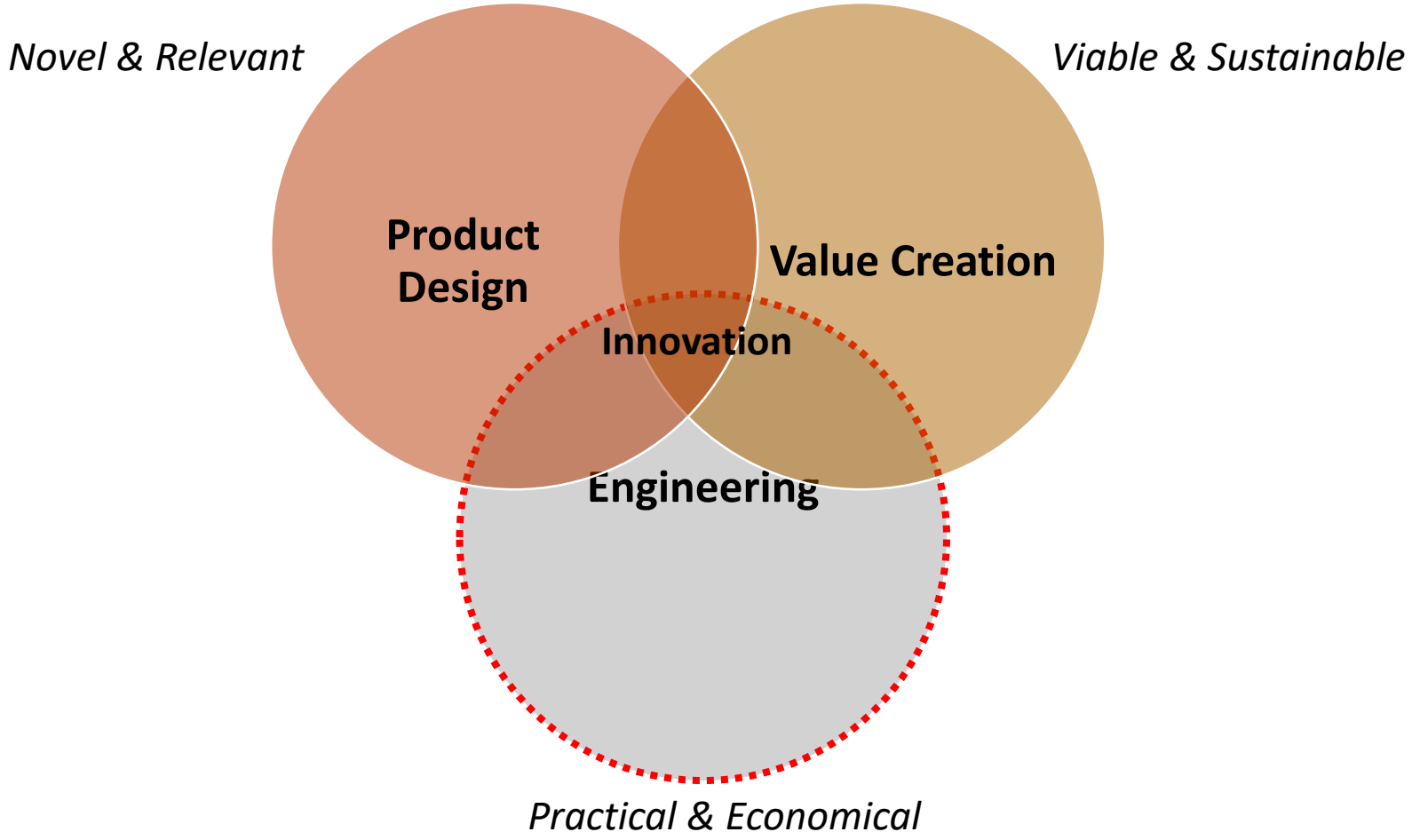
Vertically integrated curriculum to promote product design and entrepreneurial practice



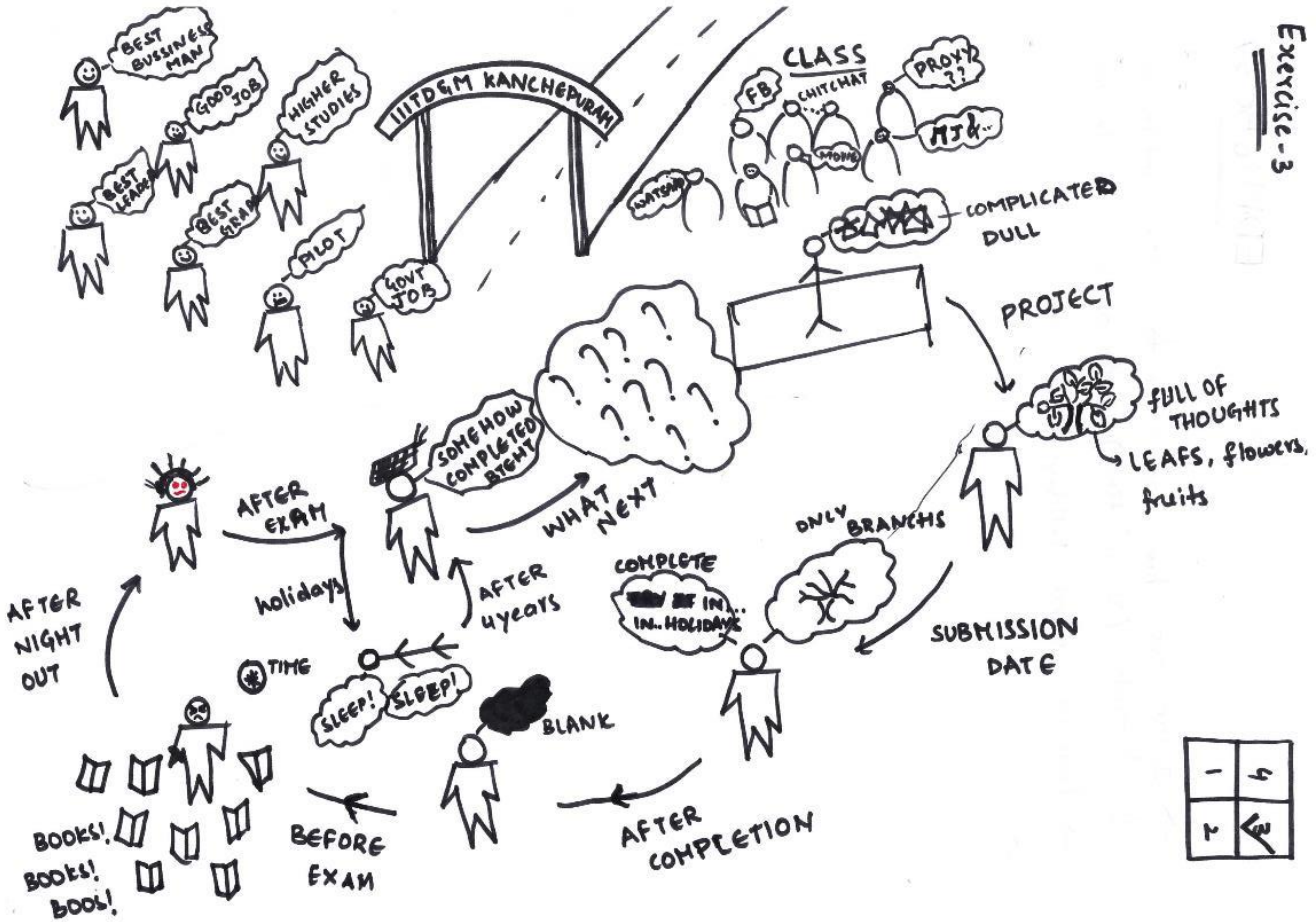
Courses to promote design thinking, product innovation and incubation



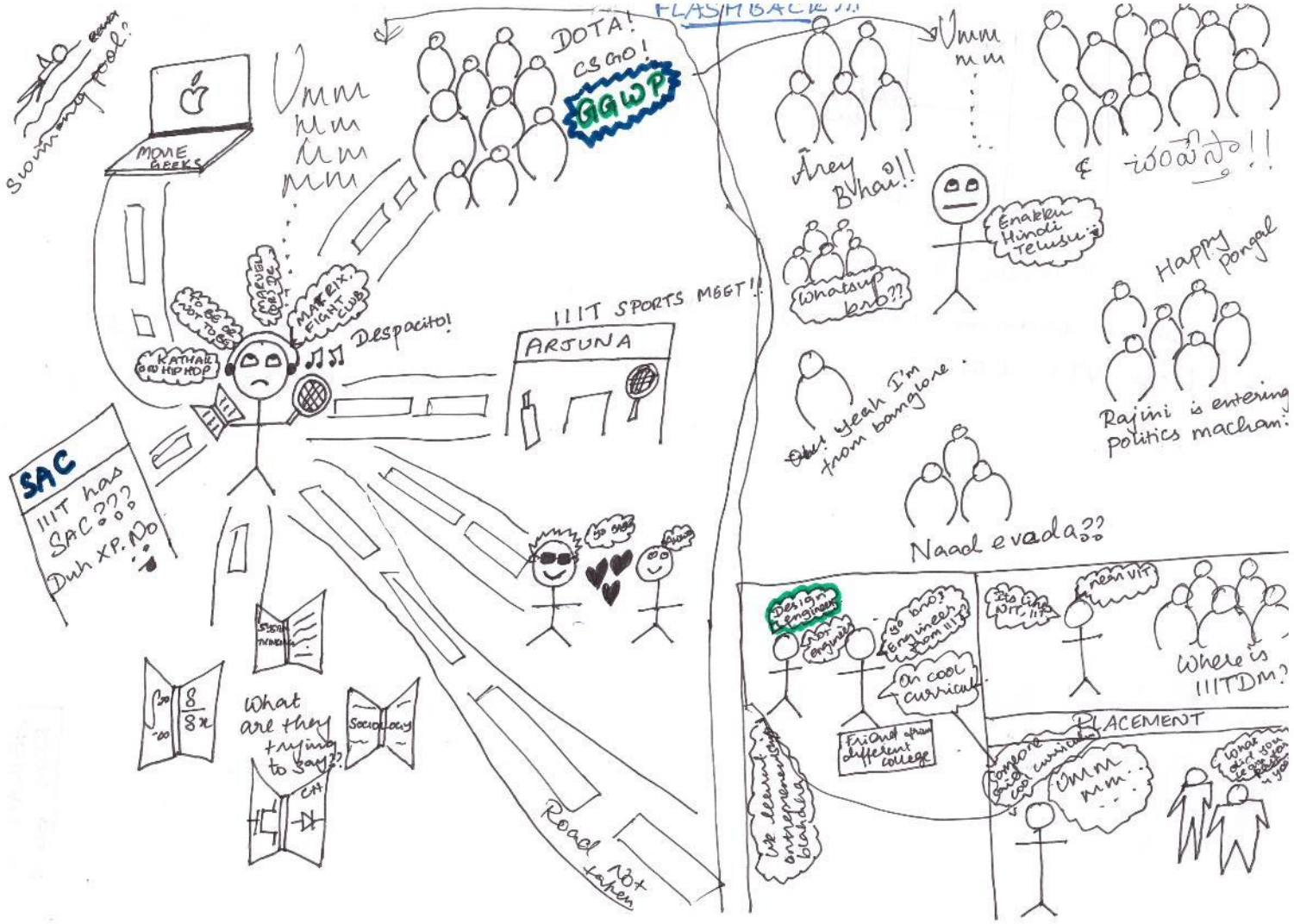
Summary: Intent of the Inter-disciplinary Design and Entrepreneurship Oriented Engineering



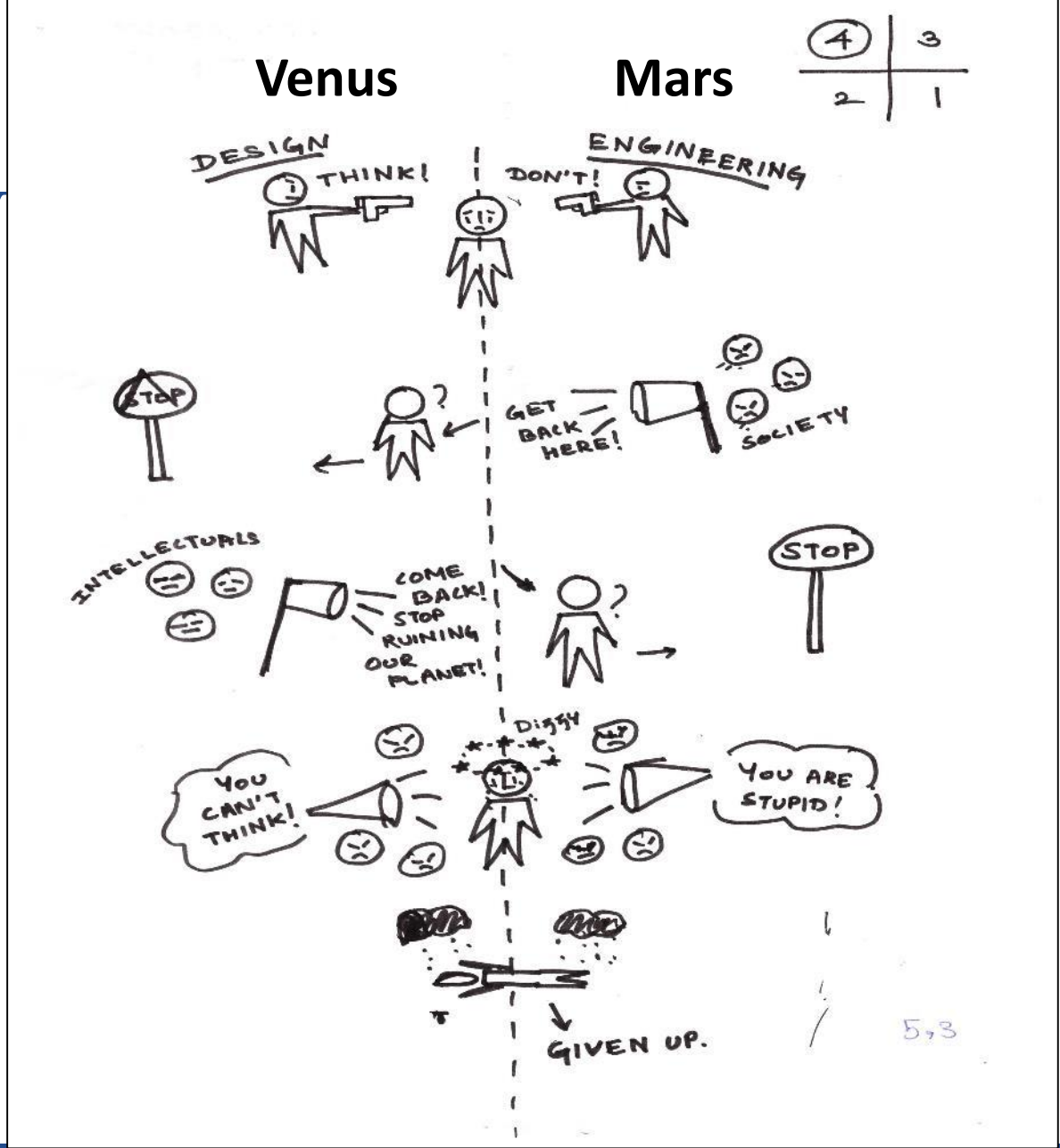
Perceptions about design emerging from expectation gaps and past habits



Perceptions about design emerging from poor time management



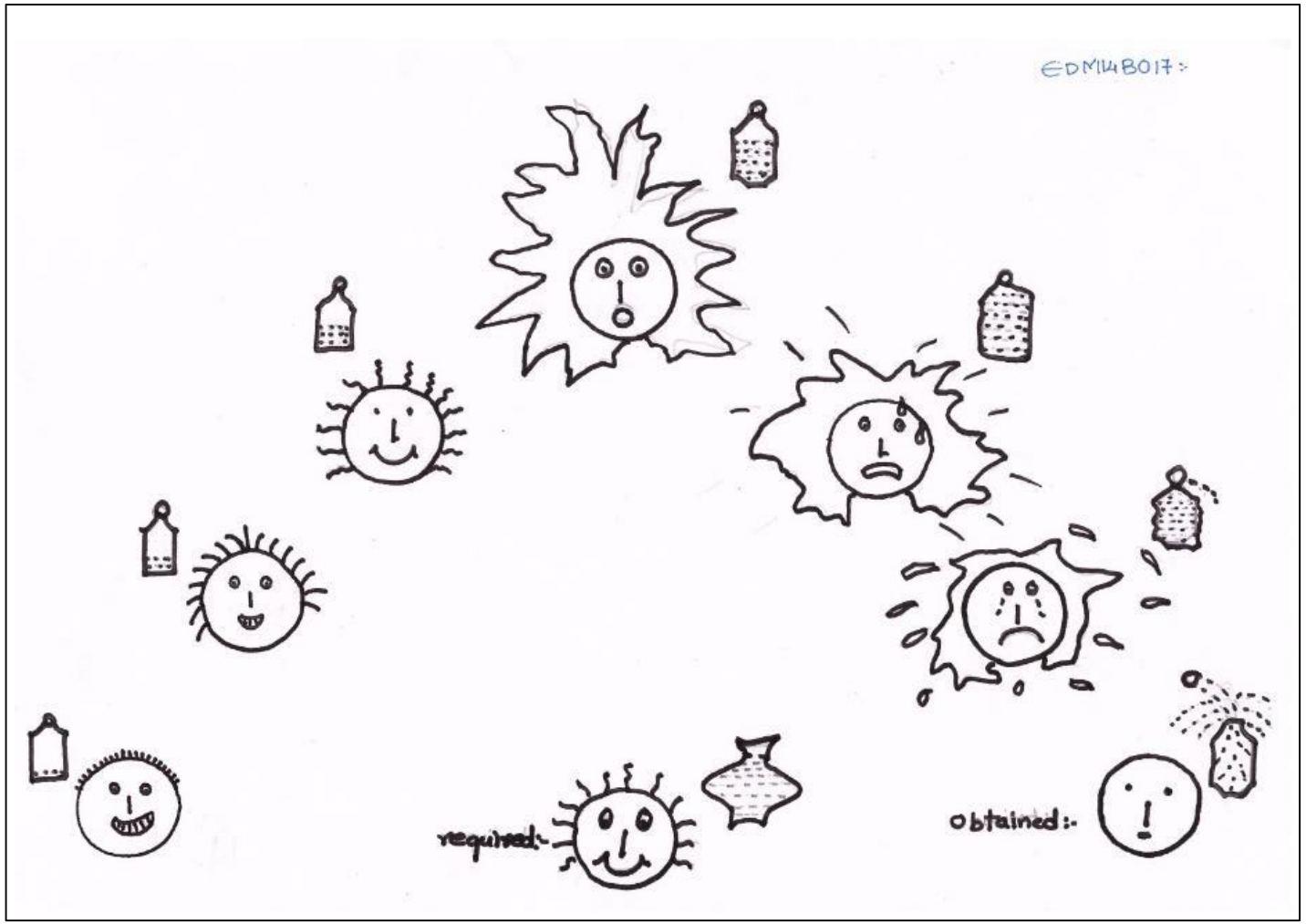
Perceptions of design emerging from contradictory messages from different paradigms



Perceptions about design emerging from deeply held beliefs – is it genetic or social?

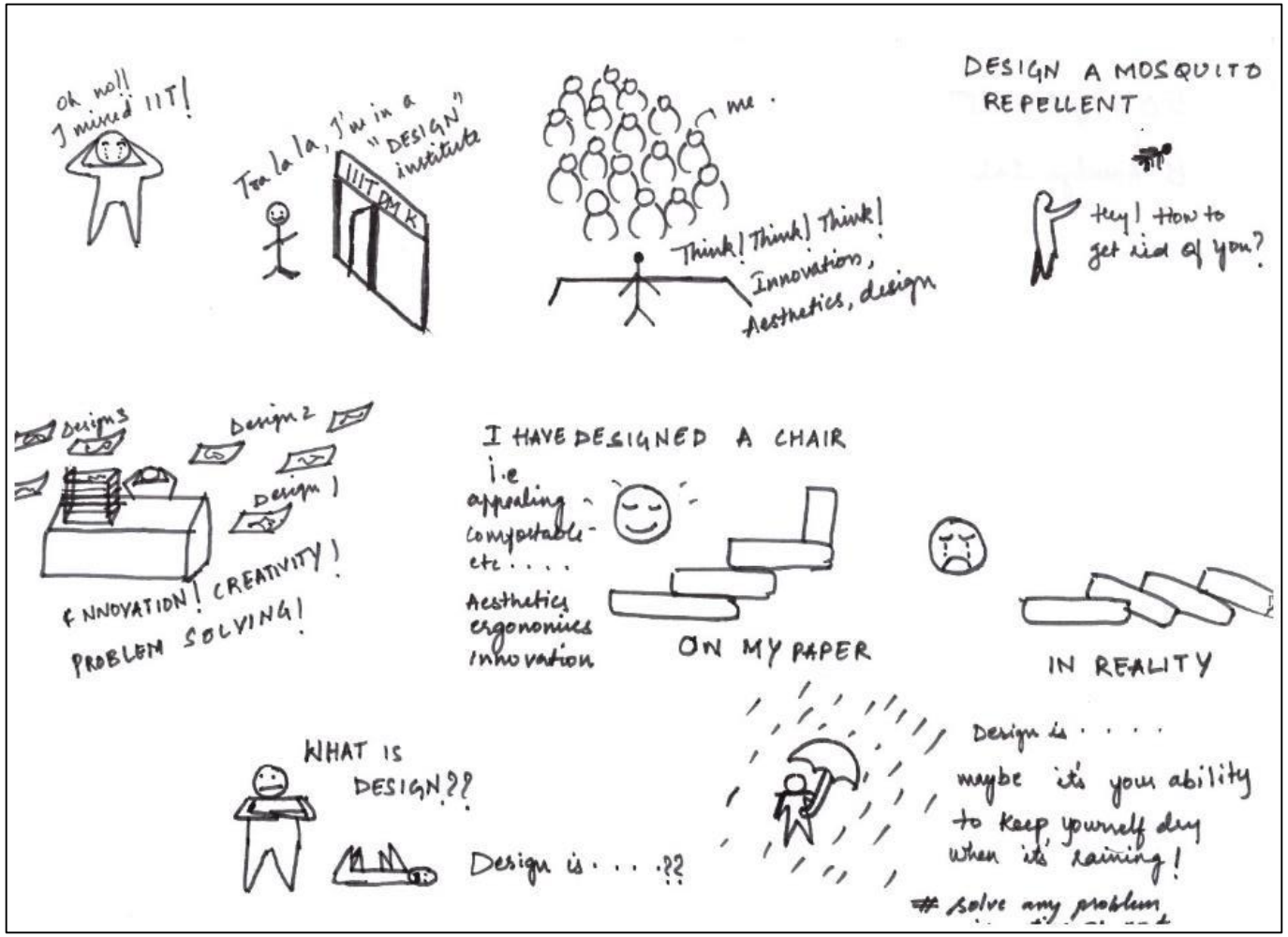
Design (is art/creativity) is in-born, cannot be trained. “You can’t make a fish climb a tree”.

Perceptions about design emerging from the complexity in the process and fear of failure



Complexity is bad, will result in unpredictable / undesirable outcomes

Perceptions about design emerging from the pedagogy – theory vs practice



Struggling to make connections

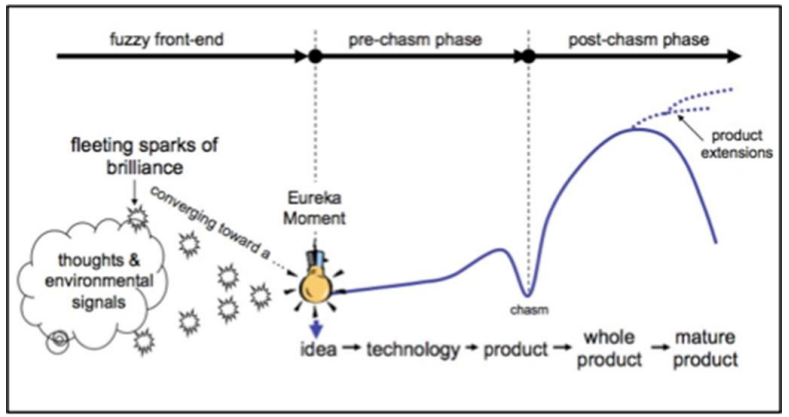
Introductory Session

IIITDM: Engineering, Design, Entrepreneurship

DES201T: Learning Objectives & Course Structure

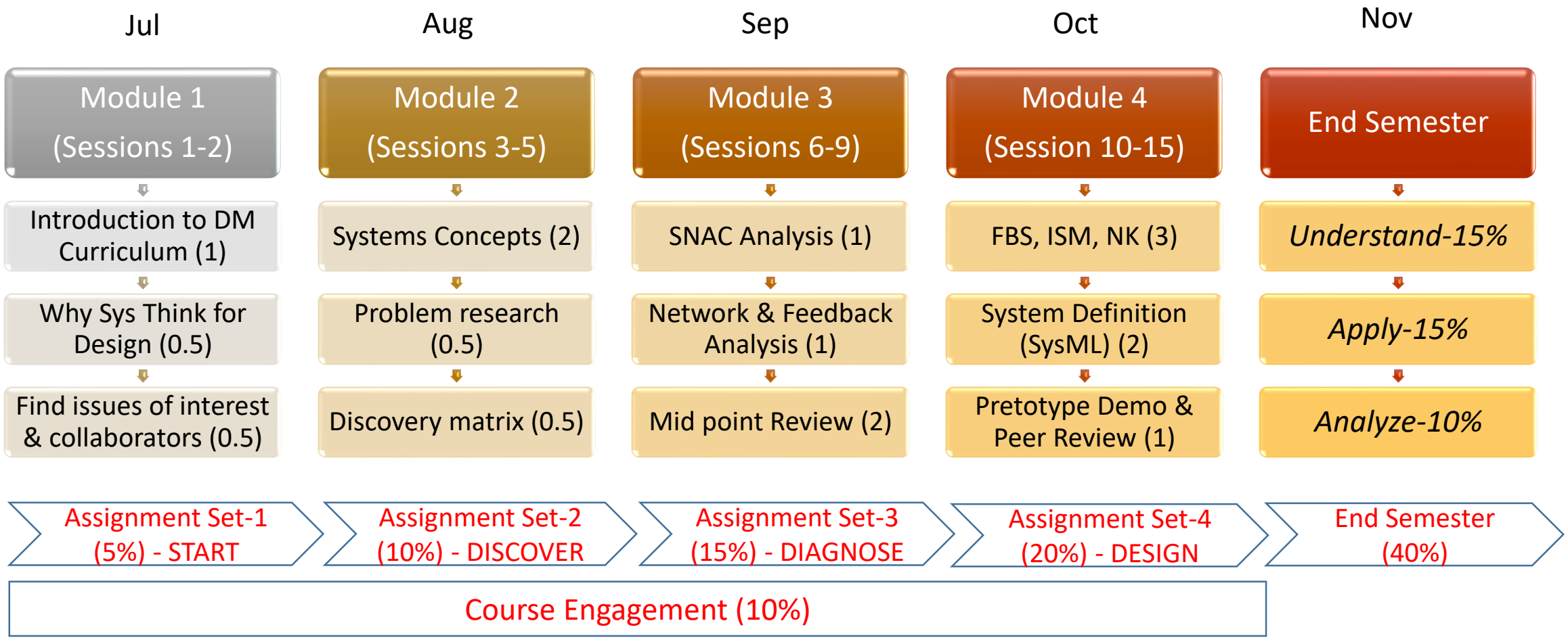
Learning Objectives and Outcomes

- **The objective of this course** is to introduce engineering students to a systemic (holistic and integrative) approach to product design in particular and problem solving in general
  - The focus will be on the issues in the **fuzzy front-end of new product development** that comes much before the detail engineering design phase



- **At the end of the course, you will be able to:**
  - Know how to identify right problems in a domain (opportunity / need identification)
  - Apply frameworks & methods to model function, behavior, structure of a system(s)
  - Model the requirements and a high level product architecture

Session and Assessment Plan



Key References

New Product Design & Engineering Design

1. Chitale, A.K. and Gupta, R.C. (2011), Product design and manufacturing, 5th edition, PHI Learning Private Limited, New Delhi (library)
2. Ulrich Karl, Eppinger Steven and Goyal Anita (2009), Product design and development, 4th edition, Tata McGraw Hill (library)
3. Pahl, G., Beitz, W, Feldhusen, J., Grote, K.H. (2007); Engineering Design: A systematic approach, Third Edition, Springer (library)

Systems thinking & Systems engineering

1. Andrew P. Sage and James E. Armstrong Jr. (2000), Introduction to Systems Engineering, Wiley (library)
2. Alexander Kossiakoff & William N Street (2003), Systems Engineering: Principles and Practice, Wiley Student Edition (library)
3. Hitchins, Derek (2003), Advanced systems thinking, engineering and management, Artech House (library)

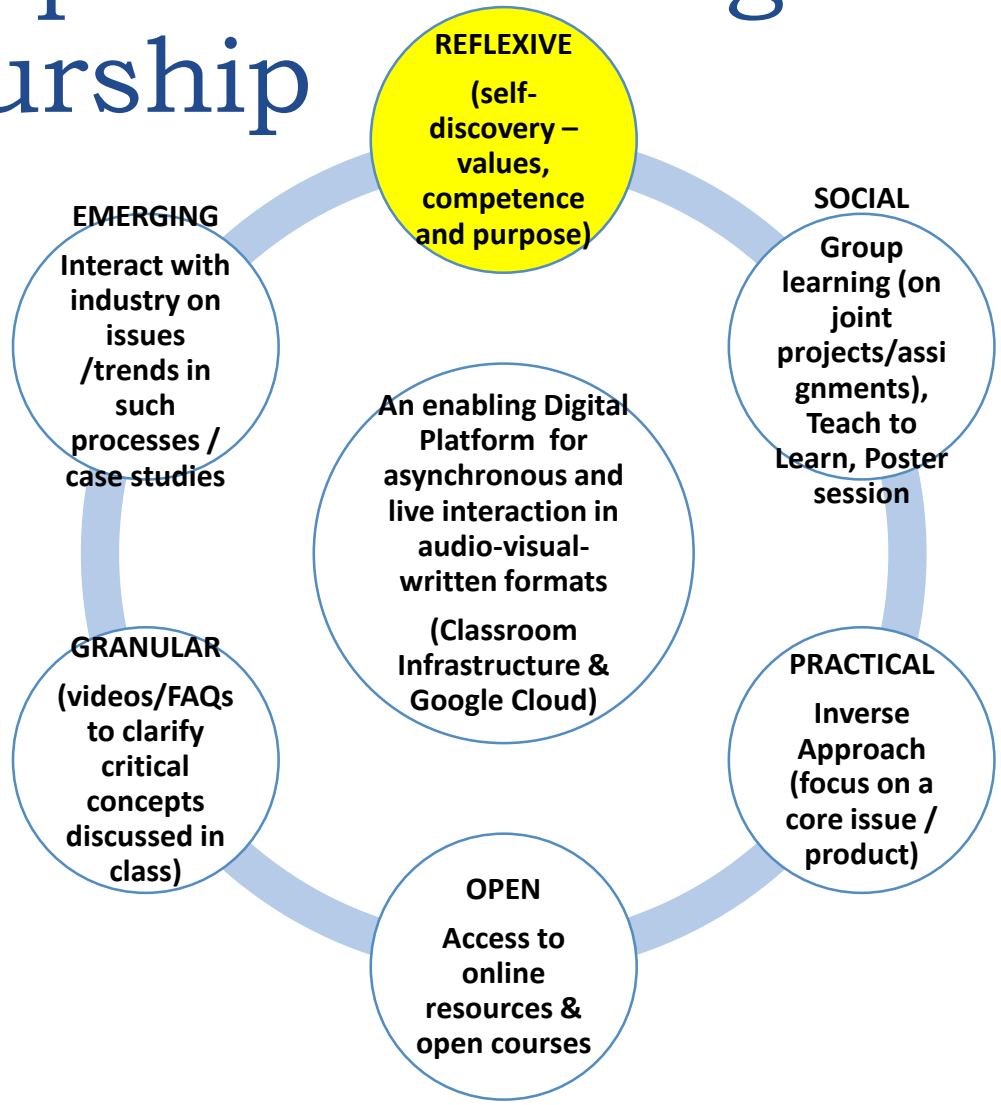
Important ebooks & papers in the portal

https://sites.google.com/a/iiitdm.ac.in/sudhirvs/courses/systems-thinking-for-design

Rules of Engagement

- Prepare and come to the class for discussion
  - Videos, course website (presentation and reading material)
  - Bring A4 sheets (4-5) for classroom work
- Work on topics of interest
  - You research and study outside the class (individually or in groups)
- Document individual and group contributions
  - To be submitted and maintained in Google Docs, Google Keep
  - Extensive use of Speech recognition
- Course engagement includes individual and group participation
  - Attendance (2 hr session), classroom discussion, FAQs, Timely submission

Pedagogy to promote Design & Entrepreneurship



Self-reflection: Why am I doing What I am doing?

There is a lot of information in the ordinary everyday activities. Self-reflection can help you notice that

It is a practice that can differentiate between 20 years of experience and 1 year experience repeated 20 times

Exercise 1.3: Take the first step in self-reflection (20 min)

- Write a note reflecting on
  - Who you are? Where are you coming from (roots/ideology)?
  - What inspires or frustrates you?
  - Why engineering?

Prepare for Next Session