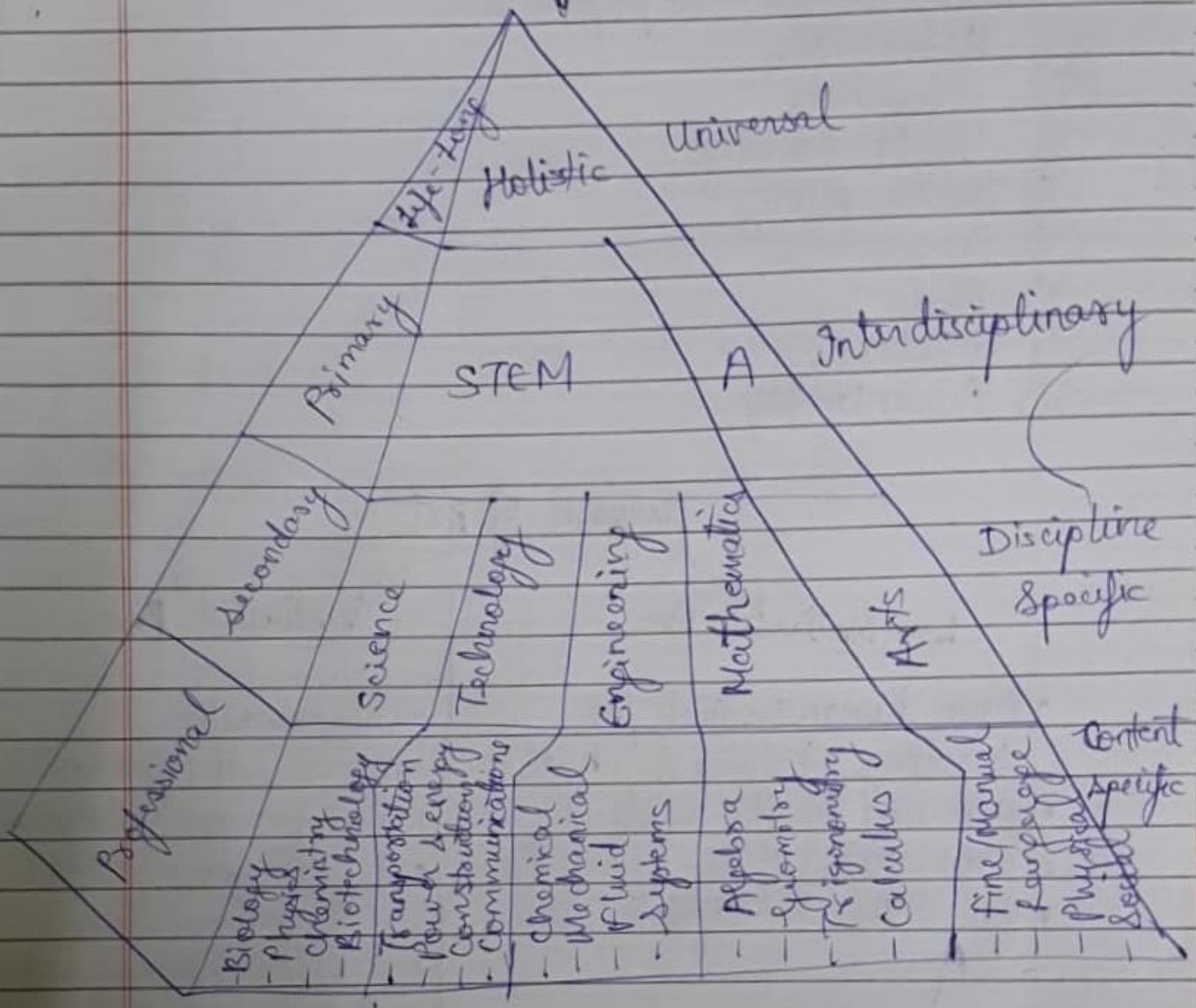
DATE: __/__/____
PAGE _____

Phil of Engg. (Unit-1)

STEAM Pyramid



→ Science provides a methodological tool in the art and art provides creative model in the development of science

- In 2007 George Yakman has announced STEAM in addition to the STEM. He said that by STEAM educat^{n}, we can increase their relevance to real life & interests.

DATE: __/__/____
PAGE _____

Art component- necessity in education.

(1) Creativity
(2) Improved academic performance
(3) Motor skills
(4) confidence
(5) Visual learning
(6) Decision Making
(7) Perseverance
(8) Focus
(9) Collaboration
(10) Accountability.

Purpose of Art

Non-Motivated Fns

- Basic human instinct for harmony, balance & rhythm
- Experience of the mysterious
- Expression of the imagination
- Ritualistic & symbolic fns

Motivated Fns

- Communication
- Art as entertainment
- Art for political change
- Art for propoganda or commercialism
- Art for social causes
- Art for psychological & healing purposes.

DATE: __/__/____
PAGE _____

Desired Attributes of an Engineer

1) Teamwork
2) Continuous learning
3) Creativity
4) Problem Solving
5) Analytical Ability
6) Communication skills
7) Logical Thinking
8) Attention to detail
9) Mathematical Ability
10) Leadership.

Various engineering habits of mind

~~1) Systems thin~~
1) Systematic thinking
2) Problem- finding
3) Visualising
4) Improving
5) Creative problem-solving
6) Adapting the change in technology.

P.T.O.

DATE: __/__/____
PAGE _____

#	Science	Engineering	Technology
Definition	Knowledge of general truths and laws in nature. Study of structure & behaviours of natural & physical world through experiments & observations.	Acquiring and applying scientific knowledge to build / design / create something.	The sum of all the engineered tools / devices / processes available.
Progress	Brought out by new discoveries about nature.	When new world problems arise.	When innovation takes place in engineering.
Purpose	To gain better understanding of natural phenomenon & physical world.	To solve real world problems.	To improve the quality of life.

History of Engineering

Military Engg. → (Ancient Era)

↓

Civil Engg. → (Middle Era)

↓

Mechanical Engg. → (Renaissance Era)

↓

DATE: __/__/____
PAGE _____

↓

Electrical Engg.

↓

Electronic Engg.

↓

chemical Engg.

↓

Aeronautical Engg.

↓

Aerospace Engg.

↓

Computer Science Engg.

→ (Modern Era)

★ Earliest civil engineer = Imhotep

↓

constr. of pyramid of Djoser (the step-pyramid)

★ Al-Jazari (Iraqi) → built five machines to pump water for the kings.

★ William Gilbert → first electrical engineer (originator of the term "electricity")

★ Thomas Savery (mechanical engineer) → built 1st steam engine → gave rise to industrial revolution.

★ Wright Brothers → first successful airplane

Epistemology -

→ believes that knowledge is a mental state.

Ontology	Epistemology
• what is existence? • what is the nature of existence?	• what do you know? • How do you know it?
→ about what is true	→ ~~figuring~~ figuring methods of out those

ontology	Epistemology
↓	↓
what's out there to know?	what & how can we know about it?

UNIT-2

Ontology

- branch of philosophy (metaphysics) that studies concepts such as existence, being, becoming, and reality.
- includes questions of how entities are grouped into basic categories and which of these entities exist on the most fundamental level.

■ science of being.

★ Three main theories about the nature of reality:-

1) Realism
2) Idealism
3) Phenomenology

1) Realism → • realist vision corresponds to common sense
• external reality & human mind (object & subject) are distinct.
• external reality is independent from the human mind.

2) Idealism → • Idealist vision believes that everything of which we have a perception is a product of the human mind.
• Perception can mislead or distort reality → Sun going around Earth but contrary is happening.

phenomenological approach

3) Phenomenology → asserts that our perception of the world, both it's tangible & abstract objects (eg → mathematical formula) is built in, and by our conscience.

Reference Ontology & Application Ontology:

(*) Reference Ontology

→ 3 central characteristics :→

(i) Theoretical focus on representation:

- ROs are constructed without any particular concern for computational efficiency.
- unapologetic use of full first-order languages.

(ii) Philosophical inclination towards realism:

→ 2 elements of this realism:→

- Metaphysical realism: Reality (the world) exists objectively in itself, independent of any mind.
- Epistemological realism: World is knowable by us.

(iii) Methodological emphasis on truth:

- central fn of ontology → represent the world accurately & comprehensively.
- quality of an ontology is a fn of it's accuracy & comprehensiveness.
- ontology of time: whether time is discrete, continuous, or some combination of the two.

⭐ Application ontology

→ 3 salient features :→

(i) Theoretical focus on Reasoning :→

- typically designed with some sort of computational application.

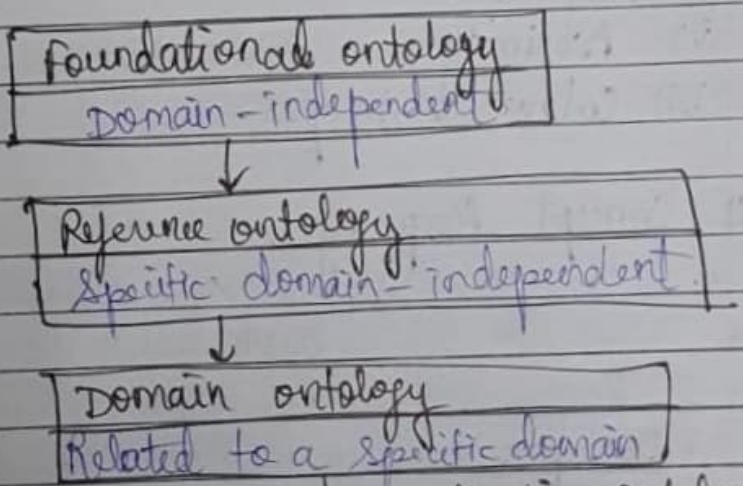
(ii) Philosophical inclination towards pragmatism / instrumentalism / constructivism.

- Take a far more pragmatic view of the world both metaphysically & epistemologically.

(iii) Methodological emphasis on fidelity.

faithful expression of the concepts / intuitions of relevant domain experts or sources.

■ Ontological layers



Reference Ontology	Application Ontology
• Theoretical focus on representation	• Theoretical focus on reasoning
• No computational efficiency	• some sort of computational application.
• maximal coverage	• minimal terminological structure.
• Fits the need of a large community.	• Fits the need of a specific community (lightweight ontologies)

• can't be derived from application ontology. • designed acc. to the strict ontological principles.	• can be derived from reference ontology. • designed acc to the viewpoint on an end-user in a particular domain.

Mind Mapping

- tool for the brain that captures the thinking that goes on inside our head.
- helps us think, collect knowledge, remember & create ideas.
- make us a better thinker.

(i) Central theme
(ii) Associations
(iii) Curved lines → Brain likes curves
(iv) Keywords
(v) Proximity → words that are close are connected.
(vi) Colour & images

Concept Mapping

- diagram that shows relationship b/w different ideas
- helps us understand how they are connected

→ 2 key elements:→

- Concepts → represented by circles, ovals or boxes & are called "nodes".
- Relationships:→ represented by arrows that connects the concepts
  → sometimes include a connecting word as verbs
  → also called "cross-links"

★ Purpose of Concept Mapping.

- Dig into a topic in detail
- Organise your thoughts
- Remember important information
- Understand relationships.

★ Types of concept mapping :→

1) Spider map → • radial pattern with core idea in centre.
→ use it when we have a single idea or theory to build upon.

2) Flowchart → • shows the steps of a process.
→ use it when we need to understand a process or make a decision.

3) Hierarchy map → • shows structure and order
→ use it when we need to understand the elements of a system, along with which elements are in the highest position & which are in the lowest position.

4) System map → • most complex of all types of concept maps.
• shows all of the diff. parts of a concept & how they are interrelated.
• Connecting lines can include a '+' or '−' to note positive or negative correlations.
→ use it when we need to understand the inner working of how a system or team is functioning.

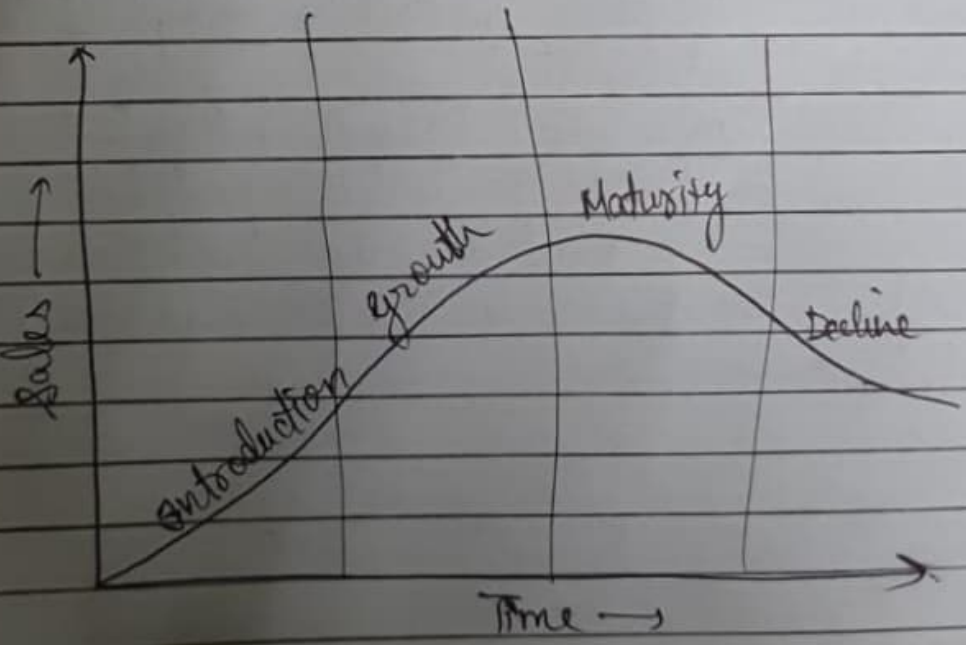
Product life cycle (PLC)

Stage-1: Product ~~Development~~ / Introduction:→ · The new product is introduced ~~to the market when all of the research & development happens~~

Stage-2: Product growth :→ The product is more than an idea or a prototype.
→ At this stage, the product is ~~manufactured~~, marketed, or released.
→ Distribution increases, demand increases & competition also increases.

Stage-3: Product Maturity :→ Product is widely available & there are many competitors in the market.
→ More spending on ~~the advertisement~~ advertising will have no impact on it's demand.

Stage-4: Product Decline :→ The product is losing market share or becoming obsolete as the demand decreases.



- PLC affects the average selling price (ASP).
  ↓
  how much you generally sell your products or services for.

→ When a product has many competitors or it's in the decline stage of it's PLC, the ASP will be lower.

→ Product image also drives the ASP.
Product with an image of exclusivity have a higher ASP
~~For eg~~ → Louis Vuitton luggage is considered a luxury brand ~~that products~~ that are made by hand & used the finest materials.
  ↓
  increased it's prices in 2013

- Closed loop Manufacting cycle is preferred as it takes our used products back into raw materials, not just assigning them to waste.
→ Although many of these closed products are down-cycled (converted into lesser-quality materials), the ~~products~~ products are still recycled & reused repeatedly.

Unit-3

Epistemology of Engg:

Theory of Knowledge.
→ Natural Science
→ Arts
→ Mathematics
→ Technology
→ Engineering
→ Social Science

* Theodore Van Kármán
"Scientists study the world as it is; engineers create the world that has never been."

Four Dimensions of Engg.

Social Sciences	Basic Sciences
engineer as sociologist	engineer as scientist
engineer as designer	engineer as does
Design	Practical Realization.

① Dimension of Basic Sciences
Views engineering as:
(a) Application of natural & exact science.
(b) stressing the value of logics & rigours.
(c) seeing the knowledge as produced through analysis & experimentation.

Date / /
Page No.

q) Research ~~preferred~~ as → major part of this dimension.

→ Discovery of first principle is seen as the activity leading to higher recognition.

② Dimension of Social Sciences

The social dimension of engineering sees engineers not just as technologists but also ~~as~~ as social experts, in their ability to recognise the social nature of the world they act upon & the social complexity of the teams they belong to.

③ Dimension of Design

- The design dimension sees engineering as the art of design.
- It values system thinking much more than the analytical thinking that characterizes traditional science.

④ Dimension of Practical Realization

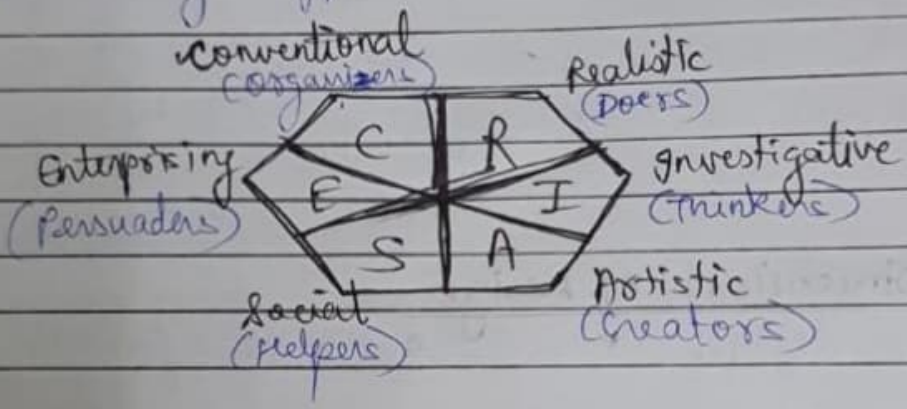
- The 4th mode views engineering as the art of getting things done, valuing the ability to change the world and overcoming complexity with flexibility & perseverance.

P.T.O. →

RIASEC Model

→ In 1950s, John Holland theorized that personality & working environment are measurable and that the two should be matched in order to find a satisfying career.

→ The goal is to match an individual's code, or personality type, with his or her career.



Epistemology of Engg. Design

1) Design as activity → • "art versus technique"
• "form versus function"

2) Design as planning →

3) Design as epistemology →

PHILOSOPHY OF ENGINEERING

UNIT- IV

Methodology of engineering

Difference b/w Scientific Method & engineering Design

- Because scientists & engineers have diff. objectives they follow different processes in their work.

Scientists	Engineers
perform experiments using scientific method	follow the creativity-based engineering-design process.
❑ Scientific Method • State your ques • DO background research • Formulate your hypothesis, identify variables • Design experiment establish procedure. • Test your hypothesis by doing an experiment • Analyse your results & draw conclusions. • Communicate results.	❑ Engineering Design Process • Define the problem • DO background research • Specify requirements • Create alternative sol"s choose the best one & develop it. • Build a prototype • Test & redesign as necessary • Communicate results.

ADDIE Model

→ generic process traditionally used by instructional designers & training developers.

→ ISD (Instructional Systems Design) model

→ most of the current ISD models are spin-offs or variations of the ADDIE model; other models include the Dick & Carey and Kemp ISD models.

→ commonly accepted improvement to ADDIE model is rapid prototyping.

ADDIE: Analysis > Design > Development > Implementation > Evaluation

A (Analysis Phase)

- Analysis of needs, requirements, tasks, participants' current abilities.

D (Design phase)

- Design learning objectives, delivery format, activities & exercises.
- Design phase should be systematic & specific

3) D (Development phase)
- Create a prototype
- Develop course materials
- Review
- Pilot session

4) I (Implementation phase)
- Procedure for training the facilitators & learners is developed.

5) E (Evaluation phase)
- formative
- summative
- feedback from the users & evaluate the results

CDIO engineers in industry
conceive → design → implement → operate.

- C (conceive)
  - Defining customer needs
  - Considering technology & regulations
  - Developing concepts, techniques & business plan.

- D (Design)
  - Creating the design of the plans, drawings & algorithms that describe what will be implemented.

- I (Implement)
  Transformation of design into the product, including manufacturing, coding, testing & evaluation.

- O (Operate)
  using the implemented product to deliver the intended values; including maintaining, evolving, & retiring the system.

Engineering Design Process

series of steps that engineers follow to find a sol^n to a problem

→ steps include problem solving processes such as determining your objectives & constraints, prototyping, testing & evaluation.

1) Define the problem
2) Brainstorm possible sol^{n}s
3) Research ideas / explore possibilities
4) Establish Criteria & constraints
5) Consider Alternative sol^{n}s

6) Select an Approach

7) Develop a Design Proposal

8) Make a model or prototype

9) Test and Evaluate

10) Refine the Design (faults)

11) Create the soln

12) Communicate the results

Operational Factors in System Design

1) Integrity & consistency

2) Performance and Scalability → Design → code → web application → scalability

3) Deployment Strategy → continuous integration / deployment (CI / CD)

4) Security

5) User Experience & Inclusivity

6) Recovery & Planning → Data Recovery (DR) & Business continuity planning (BCP)

7) Unit Testing

8) Application Performance Monitoring

UNIT-V

AXIOLOGY OF ENGINEERING

Engineering & Society

1) Health
→ Advances in medical technology is solely down to engineers.

2) Technology
→ Engineers are the reason for the phenomenal growth in technology of every generation.
→ We can access the world with our fingertips.
→ Engineers have also allowed us to build satellites & machines that helps us to understand the world we live & shape our lives on a daily basis.

3) Communication
→ We can now get in touch with people at any time of the day & in any part of the world.

4) Development
→ Improvements to travel (steam engines, jet engines, airplanes, etc) have changed the way humans connect with one another.

5) Space
→ Visiting the space has been made possible by engineers.
→ The International Space Station is the largest & the most complex space undertaking ever.

DATE: __/__/__
PAGE

* Engineering is continuing to affect society in a great & benificial way.

Sustainability & Diversity

(*) Sustainability → Development which meets the needs of the present generations without compromising the ability of the future generations to meet their own needs.

* Balance b/w 3 E's (Environmental, ethics & Economic) can lead to sustainable development.

1) Environment
- most discussed aspect of sustainability.
- Companies are making huge efforts to reduce their carbon footprints, waste, water usage, non-environmentally friendly packaging & the overall -ve impact on the environment.
- A diverse, equitable and inclusive workspace improve the environmental impact of a company.
(i) Equity and inclusion helps create equitable & inclusive processes.

(ii) Inclusive leaders have higher cultural intelligence & skills to manage diversity.

(iii) Diversity helps to build better strategies

(iv) Diverse teams are more innovative & better prepared to take bold actions.

- Diverse companies are 20% more innovative & 35% more likely to outperform homogenous companies (McKinsey 2017)

2) Ethics (Social / Equity)

→ one of the most overlooked aspects while developing sustainable strategies.

Concept of social license

↓

company & it's measures should be supported by stakeholders, employees & the community it operates in.

Ethical social impact

↓

- treating their employees fairly
- no discrimination policies
- flexible working hours
- fair wages
- ethical sourcing
- understanding the supply chain.

→ A diverse, equitable, and inclusive workspace improves the ethical & social impact of a company.

(i) Promoting equity in the company: ensures that everyone has access to the same opportunities & treatment.

(ii) Inclusion leads to conscious decision-making.

(iii) Inclusive workplaces have better psychological safety.

(iv) Diversity & inclusion help the company reach a wider audience & avoid discriminatory pitfalls.

3) Economic (E#3: Economic)

→ Not just about being profitable; but also having good governance within the company.

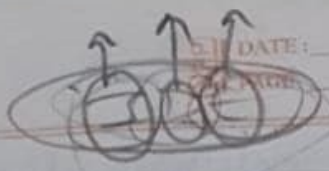
→ A diverse, equitable & inclusive workpace improves the economic impact of a company.

i) Diversity with inclusion is profitable to the business! → Diverse boards worldwide make 43% higher profits than homogenous boards.

(ii) Inclusive organisations promote transparency.

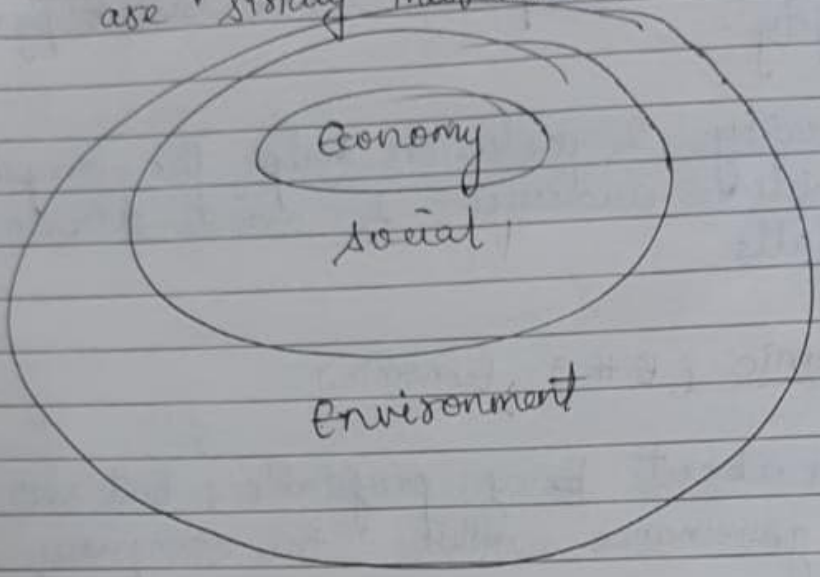
(iii) Teams with higher empathy are better equipped to deal with conflicts of interests & confrontations.

(iv) Diverse & inclusive teams promote a trustworthy brand image!



~~Sustain~~

→ Sustainability and diversity equity & Inclusion (DEI) are strictly interlinked.



Professional organizations for Engineers

- National Society of Professional Engineers
- IEEE
- American Association of Engineering Sciences
- Society of Women Engineers
- International Engineering Consortium

1) National Society of Professional Engineers (1934)

- currently one of the only non-technical organization in the country to support engineers.
- has stated goal of addressing the non-technical concerns of licensed & professional engineers.
- Multi disciplinary national organization

2) IEEE
- World's largest technical professional organisatn.
- 4,20,000 members spanning over 160 countries.

3) American Associatn of Engineering Societies (1979)
- one of the 5 best professional organisatn for engineers.
- multidisciplinary organisatn dedicated to the knowledge & practice of the field.
- non-profit organisatn → aims for collective voice for the engineering communities within the U.S.

4) Society of Women Engineers
- leadership workshops, educational programs.
- one of the best professional organisatns

5) International Engg. Consortium (IEC) (1944)
- leading non-profit organisatn
- brings together both universities & engineering societies for the purpose of continuing education of engineers.
- IEC is also the head of Electrical & computer Engg. Department Heads Association.