



# Quality Management in Engineering Education

...for employability and sustainable competitive advantage

# Business Environment

1



**Fast-Changing**

**Globalized**

**Competitive**

2



**Reforms in India  
over two decades**

- ✦ Abundant opportunities
- ✦ Highly competitive

3



**Auto industry Dominated  
by global players**

- ✦ Products developed in their global development centers
- ✦ High-quality factories set up by global teams
- ✦ Expats in key positions

# Indian Cos' Response – Building competitive advantage

**TQM** | **TPM** | **Lean** for business excellence



**Product and  
Process Innovation**



**Continual Improvement**



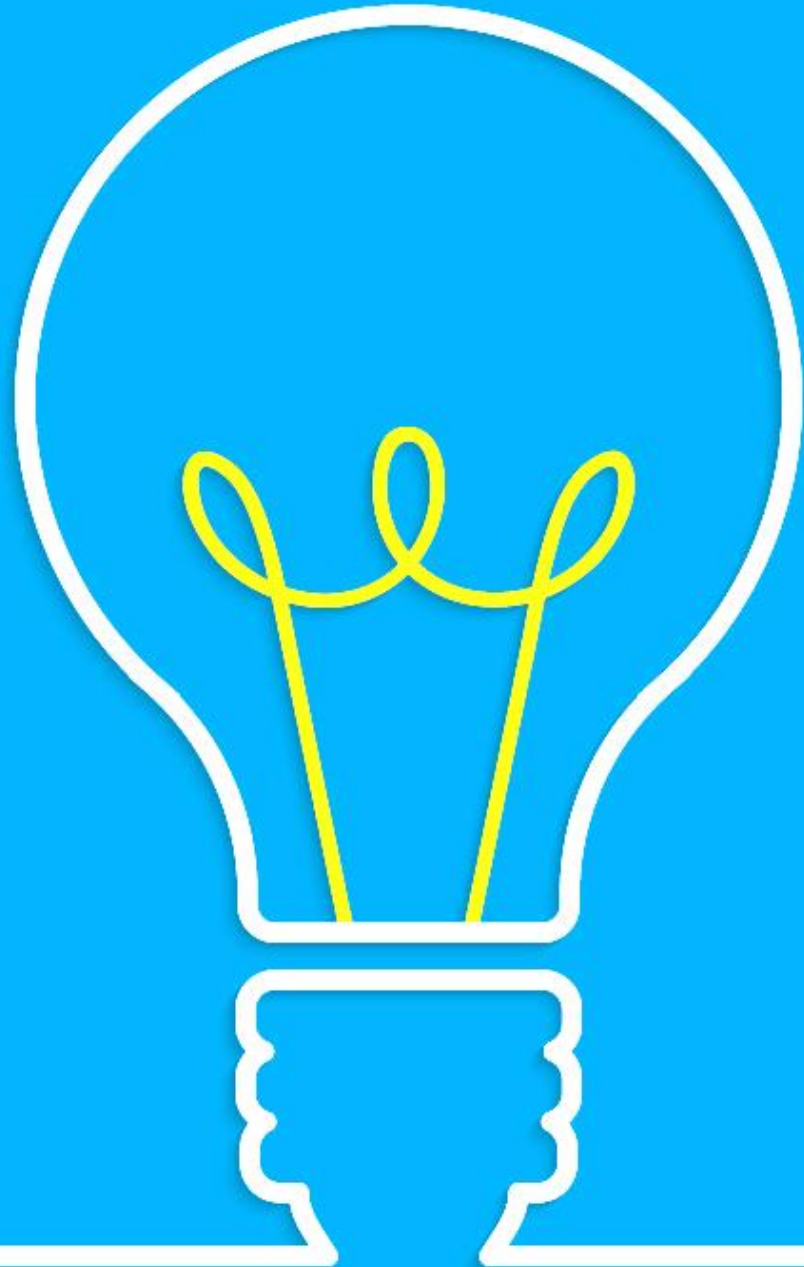
**Talent Management**

# Progress post reforms....

Many sectors have reformed, evolved and achieved global standards

- Automotive
- Aviation
- Telecom
- Banking and financial services,

**Sectors not reformed  
enough?**





# Investment in education vs Returns

- ✦ 15/18 years spent for education between the Schools and the college
- ✦ Investment in terms of money, time, and effort
- ✦ *How much of what we learnt is used in our life or career?*



# Academic System in India

Limited reforms and innovation  
for decades

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Limited academia-industry  
partnership

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Focus shifted to quantity  
with economic growth

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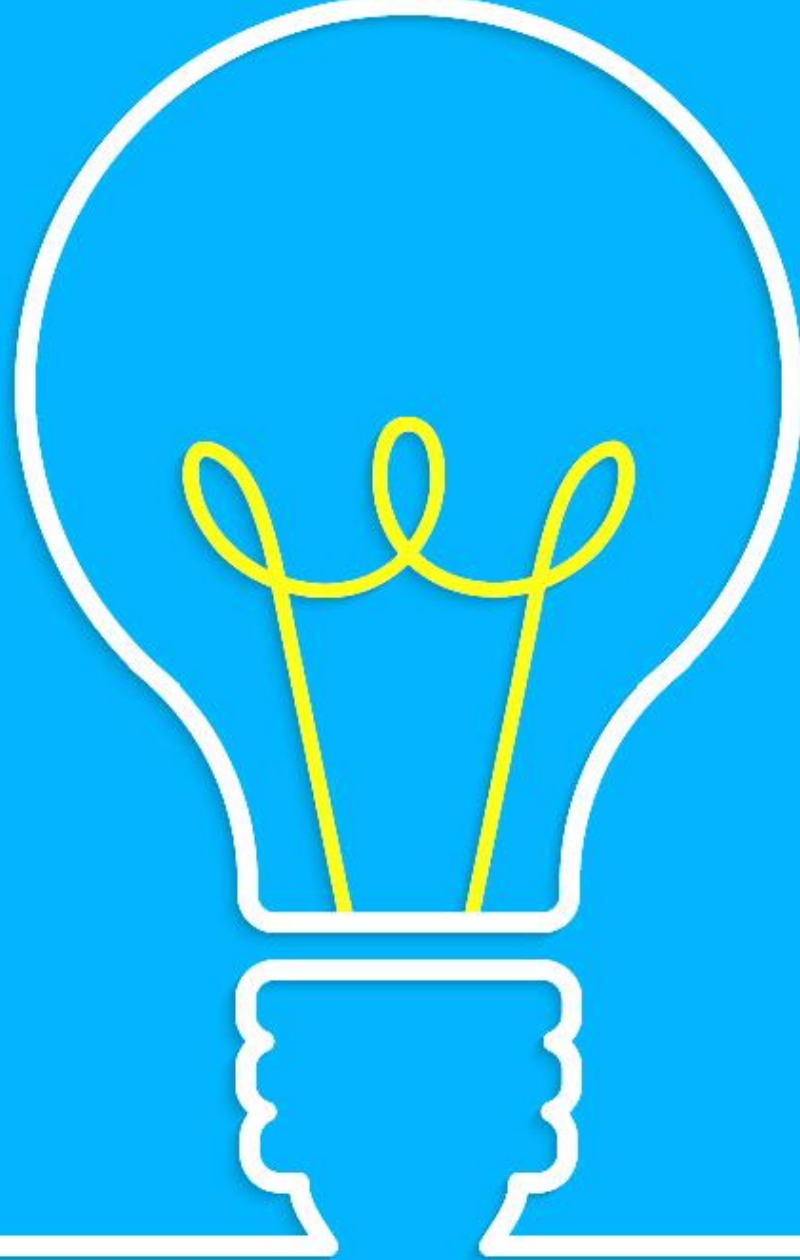
**Limited  
Employability**

Work culture in academic vs  
corporate just opposite

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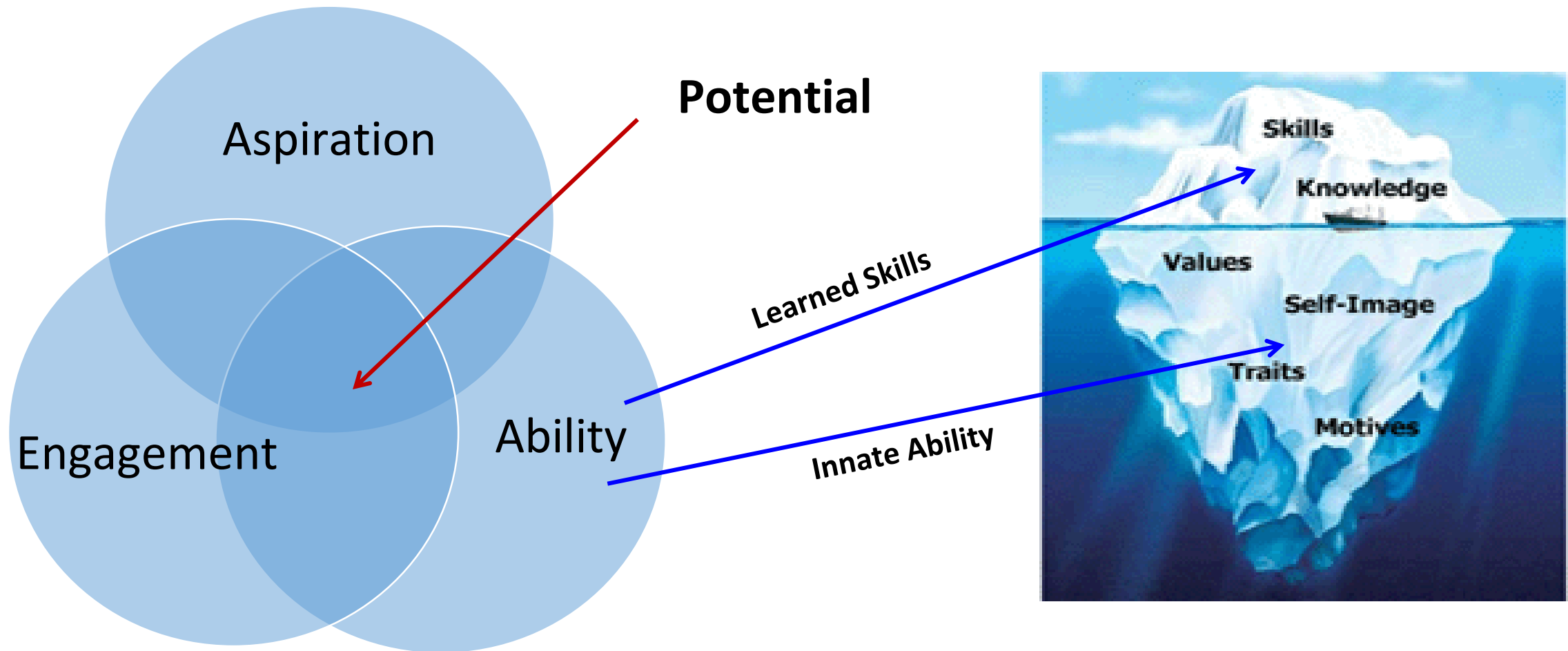
- Expansion was primarily catered to IT/ITES
- Even older institutions catered to them – easy placements
- About 500 getting placed in one IT company, Need 100 core companies

# Concepts Used for Research





# Potential and Competence



- Assess Innate abilities as the basis for selection
- Teach or learn the knowledge and skills for the specific jobs

# Assessment of Innate abilities

- Assessment center - A wide-ranging, holistic approach
  - Assessment of small groups of participants simultaneously
  - Evaluated by more than one assessor and agree on the final ratings
  - Use multiple tools/methods for evaluation including situational tests
  - Each exercise provides inputs relevant to one or more dimensions

# Domains of Learning



## THE COGNITIVE

Describes the **thought processes** that constitute various **intellectual abilities**.

- ✦ Remember
- ✦ Understand
- ✦ Apply
- ✦ Analyze
- ✦ Evaluate
- ✦ Create

## THE AFFECTIVE

Describes the **attitudes or values** that **motivate to perform** the cognitive or intellectual abilities.

- ✦ Receive
- ✦ Respond
- ✦ Value
- ✦ Organize
- ✦ Characterize

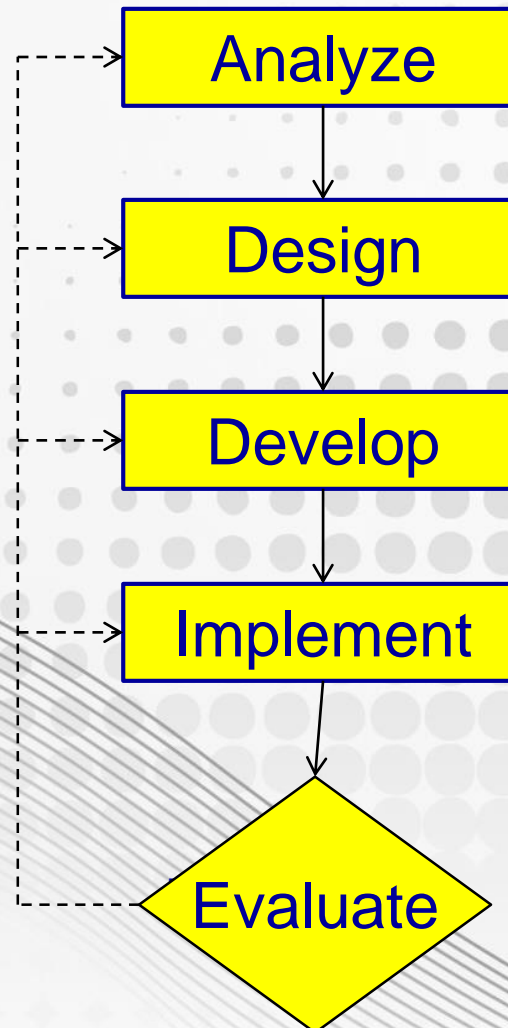
## THE PSYCHOMOTOR

Describes the **body movements** required to **perform the skills**.

- Imitation
- Manipulation
- Precision
- Articulation

# Instructional design methodology - ADDIE

- Aids the process of 'intentional' learning
- A project by a team of designers, subject matter experts, evaluation experts, and production personnel
- Learning evaluation in four levels - Reaction, Learning, Behavior, Results



- Training/Learning Needs
- Cognitive, affective, psychomotor goals
- Skills to be acquired and duration
- Performance outcomes/course objectives
- Content – topics, units, sequence and duration
- Learning methodologies/activities
- Decisions on learning activities and materials
- Draft materials and/or activities
- Teacher training or adjunct materials
- Deliver the course as planned
- Provide help or support needed
- Students' evaluation
- Program evaluation
- Course maintenance and revision

# Systems Approach



- Inter-relationships and patterns of change with 'time' and 'space'
- ✦ Describes the input-Transformation/Process-output sequence
- ✦ Technical output vs System output

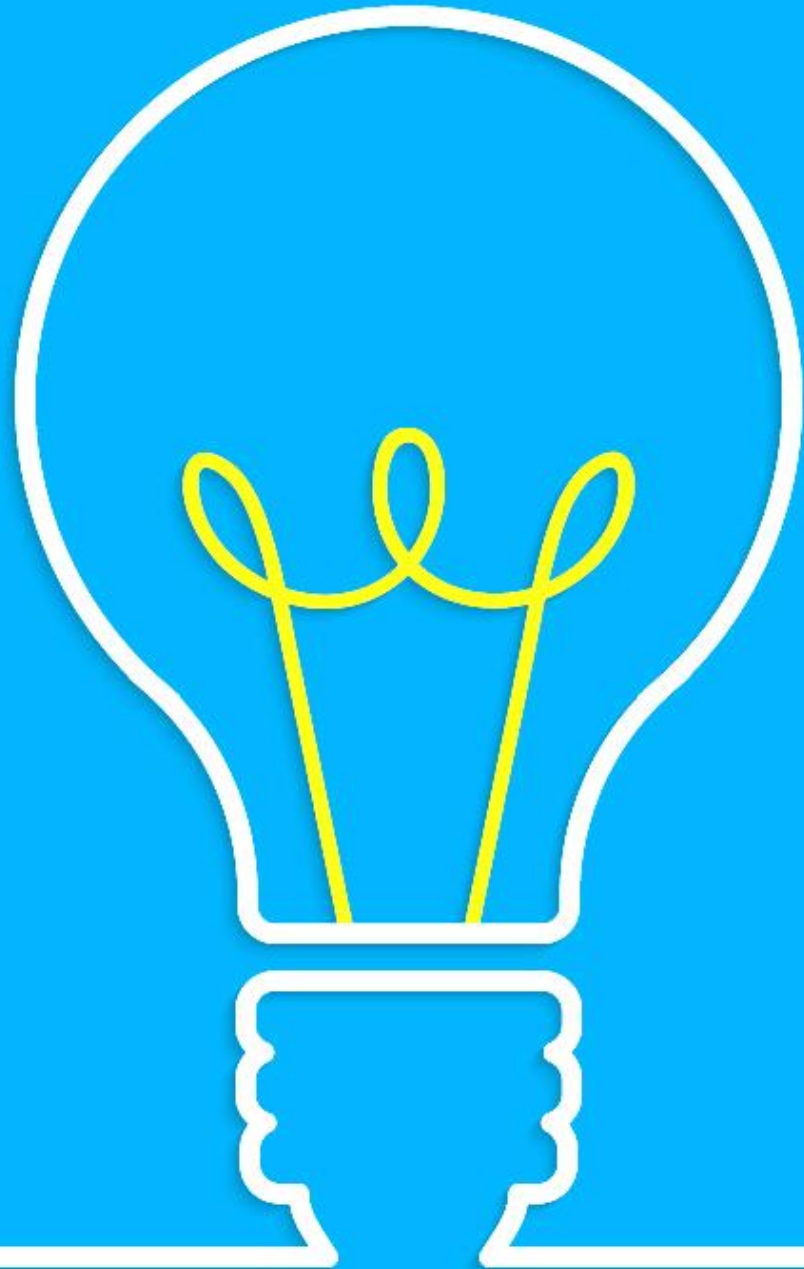


# Research objectives

Establish a holistic framework for competency management

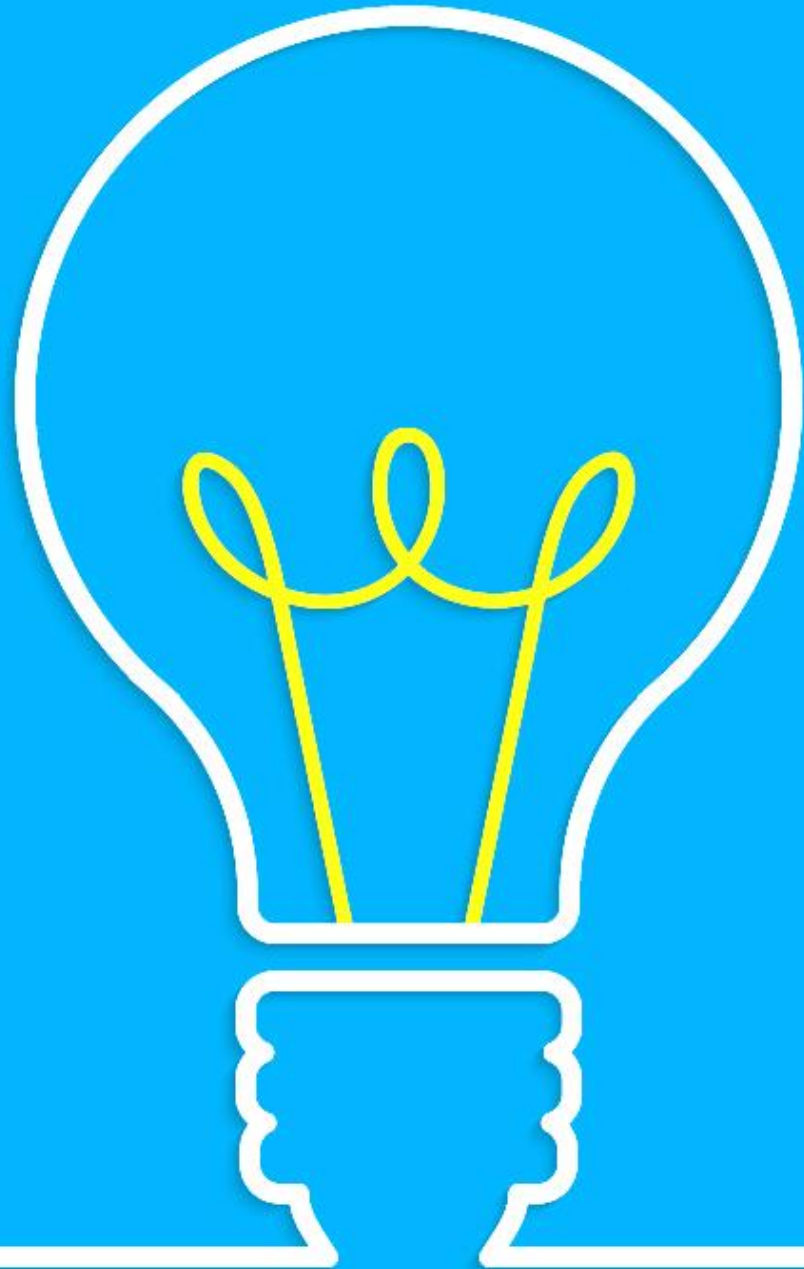
- **Select entry level students/ employees by assessing innate abilities suited for specific roles**
- **Co-create outcome-based education with stakeholders for role ready entry level talent**
- Structured process for role based competency development of employees
- Integrating competency framework with the TVS Way and business processes

**A holistic enterprise-wide  
Competency  
Management system**



# A Higher Education System

Collaborative education program  
with few institutions



# A Higher Education System for Life and Career

## Mission

Develop Aspirational, Highly-Engaged, Competent (relevant for Career and Life), Industry-ready & Role-ready engineers to excel in engineering, manufacturing and Retail Marketing best in class automotive products and in their lives.



# Systems Approach for Higher Education

## INPUT

### Mobilization & Selection

- ✦ Innate Abilities/Aptitude
- ✦ Self driven Aspiration

PEOs & POs: based on the skills for the target roles and Washington Accord

- ✦ Technical Skills
- ✦ Professional Skills

### Strong Foundation

Foundation tests and courses for Mathematics, Physics, Chemistry and English

## TRANSFORMATION

- Courses aligned with POs
- Electives courses aligned to roles
- Course map and relationships
- Course outcomes
- Design using IDM & Blooms
- Delivery and assessment

### Outcome-based Education

- ✦ Articulating Aspiration
- ✦ Co-curricular and extra-curricular activities
- ✦ Internship every semester
- ✦ Collaborative industry projects

## OUTPUT

### Technical Output

- ✦ Academic performance

### System Output

- ✦ Aspirational, highly engaged entry level talent
- ✦ Employable and Life skills for roles in industry



# Mobilization and Selection

## MOBILIZATION

**Attract the students with self driven aspiration from Rural, JNV and KV Schools**

## SELECTION

**Assessing Innate abilities: Traits, Motives and Attitudes**

## Two Days Selection Center



**Psychometric tests, Individual & Group tasks, Behavioral Event Interview**



**Qualified observers and panelists  
Selection and identification of best suited roles**

# Program Educational objectives - PEO



**Application of technical Expertise:** Actively *apply technical and professional skills* in *engineering practices towards* the *progress of the organization* in competitive and dynamic environment.



**Lifelong Learning:** *Own their professional and personal development* by *continuous learning* and *apply the learning* at work to *create new knowledge*.



**Ethical and professional conduct:** Conduct themselves in a *responsible, professional* and *ethical manner* supporting *sustainable economic development* which enhances the *quality of life*.

# Program Outcomes - PO

| Sharp definition

| Competencies as outcomes

| Professional & Life Skills

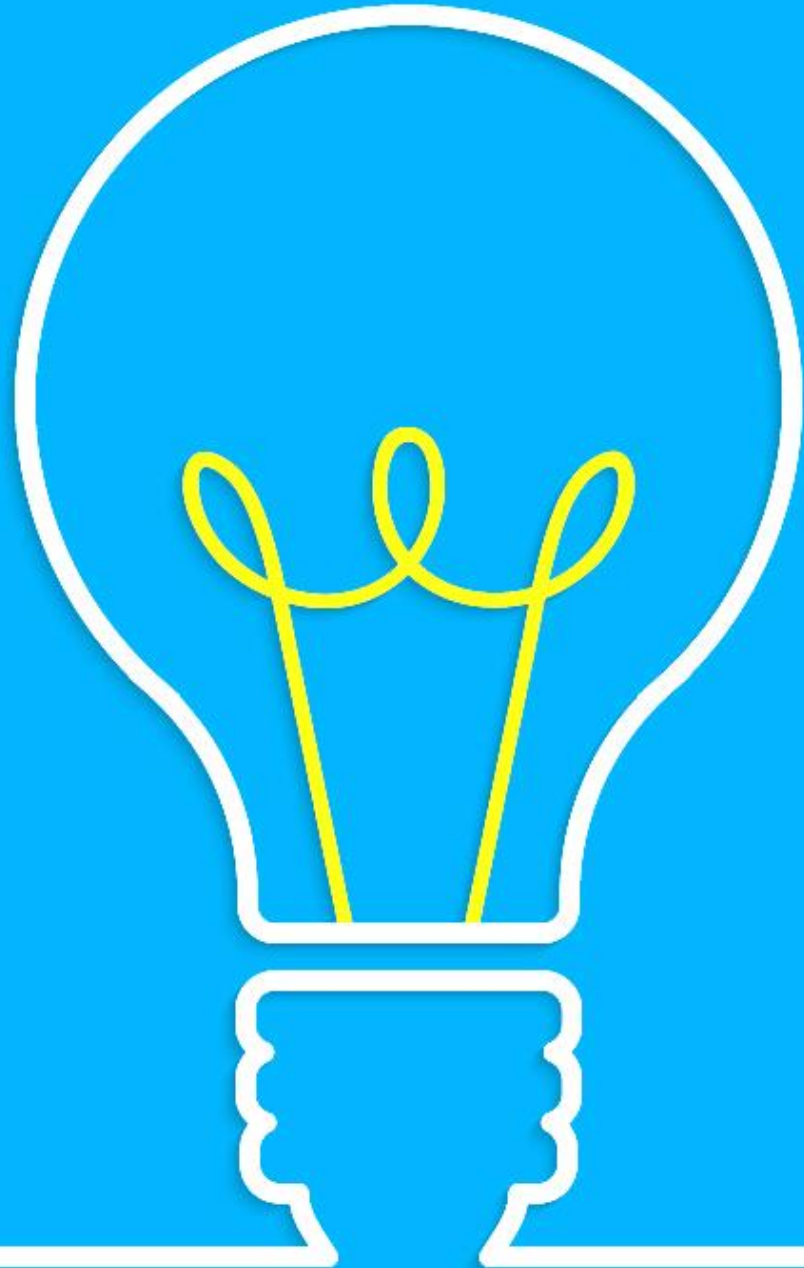
## Technical Skills

- Apply scientific principles and concepts in design and development of products and manufacturing processes & system
- Design products and manufacturing facilities that deliver the requirements of the target customers and desired quality functions
- Analyze the systems' behavior and optimize for the results using modeling, simulation and experiments
- Check and improve the DFX -assembly, manufacture, cost, quality, reliability, serviceability, recyclability etc.
- Sense, Define, and solve engineering problems using appropriate tools and techniques
- Demonstrate understanding of the dynamic industrial and business environment in which the products are designed, manufactured and sold

## Professional & Life Skills

- Demonstrate professional and ethical responsibility.
- Develop and maintain positive health - physical, mental and social wellbeing
- Articulate and engage in pursuit of career and life goals
- Plan and work to time.
- Communicate effectively through written, oral, and visual means
- Work effectively in teams and manage interpersonal relationships
- Take ownership for continuous learning
- Demonstrate versatility and adaptability in response to change
- Overcome challenges with rigor and emotional stability

# Outcome Based Education: Process



# Outcome-Based Education: Process



Identify and align the courses with program outcomes



Establish course map with relationships.



Establish course outcomes aligned to program outcomes.



Design the courses with IDM and Blooms taxonomy.



Teach/learn and evaluate effectiveness & improve.



# Aligning Courses with Program Outcomes (TS)



	Program Outcomes	Apply scientific principles and concepts in design and development of products and manufacturing processes & system	Design products and manufacturing facilities that deliver the requirements of the target customers and desired quality functions	Analyze the systems' behavior and optimize for the results using modeling, simulation and experiments	Check and improve the DFX - assembly, manufacture, cost, quality, reliability, serviceability, recyclability etc.	Sense, Define, and solve engineering problems using appropriate tools and techniques	Demonstrate understanding of the dynamic industrial and business environment in which the products are designed, manufactured and sold
	Courses						
Course Code	Name of the Course	PO 1	PO 2	PO3	PO 4	PO 5	PO 6
140ME0102	Engineering Mathematics – I	XX					
140ME0103	Applied Physics	XX					
140ME0104	Applied Chemistry	XX					
140ME0105	Introduction to Engineering	XX	X	X			X
140ME0106	Engineering Graphics	XX	X			X	
140ME0107	Engineering Practices Laboratory	X	X		X		
140ME0108	Physics and Chemistry Laboratory	X					
140ME0202	Engineering Mathematics – II	XX					
140ME0203	Material Science	X	XX			X	
140ME0204	Engineering Mechanics	XX	X	X	X	X	
140ME0205	Engineering Metrology and Measurements	XX			XX		
140ME0206	Manufacturing Process - I	XX	XX		X		X
140ME0208	Computer Aided Drafting and Modeling Laboratory		X	X	X	X	

# Aligning Courses with Program Outcomes (PS)



	Program Outcomes	Demonstrate professional and ethical responsibility.	Develop and maintain positive health - physical, mental and social well being	Articulate and engage in pursuit of career and life goals	Plan and work to time.	Communicate effectively through written, oral, and visual means	Work effectively in teams and manage interpersonal relationships	Take ownership for continuous learning	Demonstrate versatility and adaptability in response to change	Overcome challenges with rigor and emotional stability
	Courses									
Course Code	Name of the Course	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PO 13	PO 14	PO 15
140ME0101	Communication Skills- I					XX				
140ME0109	Promotion of Students' Wellness		XX						X	X
140ME0201	Communication Skills- II					XX				
140ME0209	Sports For Wellness		XX						X	
140ME0309	Personal Effectiveness		X	XX	X					
140ME0409	Ethical and Moral Responsibility	XX					X			
140ME0509	Teamness and Inter-Personal Skills (TIPS)						XX			
140ME0609	Campus to Corporate				X	X	X	X	X	X

# Elective Courses Aligned to Roles

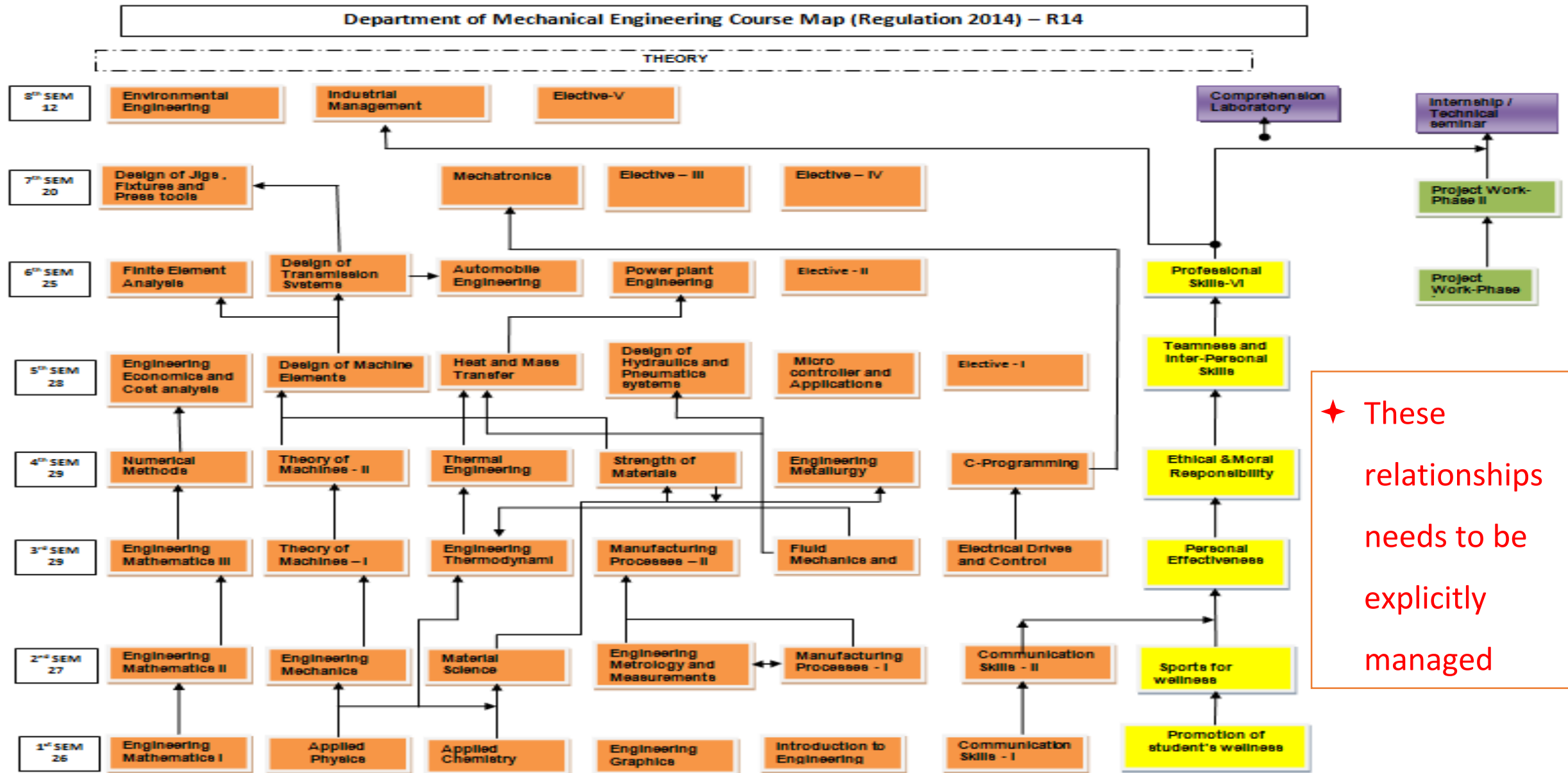


- ✦ Elective courses are used to develop automotive engineers for specific roles
- ✦ Courses developed and delivered by experts from India/Overseas
- ✦ Practicing engineers also attend these courses along with students

B.E in Mechanical Engineering (Electives aligned to role)				
Sem	<u>Common Electives</u>			
5	Product Design & Engineering			
6	Automotive Fundamentals & Manufacturing			
	Project Management			
	Systems Approach for Engineers			
7	<u>Design Stream</u>		<u>Manufacturing Stream</u>	
	Automotive Engine & systems		Logistics Engineering	
	Vehicle Design Engineering		Manufacturing Systems Engineering	
8	<u>Powertrain</u>	<u>Chassis (Vehicle)</u>	<u>Assembly &amp; Metal Cutting</u>	<u>Forming &amp; Joining</u>
	Fundamentals of Spark Ignition Engines	VDE (Statics)	Design of Assembly process, Assembly Engineering, Testing and Performance Assurance	Weld Process Engineering & Design of Weld Joint and Fixtures
	Internal Combustion Engines Design	VDE (Dynamics)	Metal Cutting Process Engineering	Sheet Metal Forming, Tube Bending & Design of Press Tools
Role	↓		↓	
Entry Level	CAD Engineer	CAD Engineer	Proving Engineer/Team Leader	Proving Engineer/Team Leader
First Level	Part Design Engineer	Part Design Engineer	Process Planning engineer/Group Leader	Process Planning engineer/Group Leader



# Course Map and Relationships



# Course Outcomes : Introduction to Engineering



At the end of the course 'Introduction to Engineering', the students will:

- Explain the career opportunities in engineering in terms of roles and competencies.
- Explain how they can acquire these competencies through an outcomes based education at MCET
- Explain how to remain relevant and versatile in a dynamic and complex environments
- Observe every product and processes with an engineering perspective and inquisitiveness
- Choose to take ownership for his/her learning and development, leveraging the resources and infrastructure.
- Identify and rectify unsafe conditions and acts and follow environment friendly practice.



# Course Outcomes : Engineering Mechanics



At the end of the course 'Engineering Mechanics', the student will

- ✦ Construct free-body diagrams and calculate the unknown forces necessary to ensure static equilibrium condition.
- ✦ Calculate the magnitude of force acting in each member of frame and machine under static equilibrium condition.
- ✦ Calculate geometric properties such as centroids and moment of inertia
- ✦ Analyze the effect of dry friction in contact surfaces (ladder ,wedge, screw and belt)
- ✦ Calculate and plot the motion of a particle

# Design Document: Engineering Mechanics



Course Outcome (CO)	Learning Outcome (LO)	Specific Outcome (SO)	Content	Bloom's Taxonomy		Methodology ( How the content will be delivered)		
(What the student will be able to do at the end	(What the student should be able to do if he/she has to do the relevant	( What the student should be able to do if he/she has to do the relevant LO)	( The content that needs to be covered if the student			Lecture		
By the end of the course, students will:	By the end of the course, students will:	By the end of the course, students will:		Type of Knowledge	Cognitive Dimension	Lecture File Name	(What faculty will do)	(What student will do)
5 Calculate and plot the motion of a particle	5.1 Calculate displacement, velocity and acceleration of particles whose uniform non uniform motion is described by governing equations, plots.	5.1.1 Explain displacement, velocity and acceleration	displacement, velocity and acceleration	Conceptual	Understand	LO 21	Delivers lecture using PPT	Listens and takes notes
		5.1.2 Explain the constant acceleration equations	constant acceleration	Conceptual	Understand			
		5.1.3 Differentiate uniform and non-uniform motion	uniform and non-uniform motions	Conceptual	Understand			
		5.1.4 Explain the s-t, v-t, a-t graphs	s-t, v-t, a-t graphs	Conceptual	Understand			
		5.1.5 Solve problems involving uniform and non uniform motion		Procedural	Apply		Solves problem	Solves problem
	5.2 Calculate kinematic parameters in curvilinear, projectile, relative and dependent motion of particles.	5.2.1 Explain curvilinear motion using tangential and normal components	curviliner motion	Conceptual	Understand	LO 22	Delivers lecture using PPT	Listens and takes notes
		5.2.2 Explain projectile motion	projectile motion	Conceptual	Understand			
		5.2.3 Explain relative motion	relative motion	Conceptual	Understand			
		5.2.4 Explain dependent motion	dependent motion	Conceptual	Understand			
		5.2.5 Solve problems in curvilinear, projectile, relative and dependent		Procedural	Apply		Solves problems	Solves problems
	5.3 Use work energy method, impulse momentum method and DAlembert's principle to calculate the forces and their actions on particles	5.3.1 Explain D Alembert's principle	DAlembert's principle	Conceptual	Understand	LO 23	Delivers lecture using PPT	Listens and takes notes
		5.3.2 Explain work energy method	Work energy method	Conceptual	Understand			
		5.3.3 Explain impulse momentum method	Impulse momentum	Conceptual	Understand			
		5.3.4 Solve problems to calculate the forces and their actions on particles		Procedural	Apply		Solves problems	Solves problems

# Assessment of Outcomes and Blooms Taxonomy



Evaluation Type	CAT 1 <sup>SEP</sup> Objective 1 to 3			CAT 2 <sup>SEP</sup> Objective 1 to 4			CAT 3 <sup>SEP</sup> Objective 1 to 5			Semester: Theory <sup>SEP</sup> Objective 1 to 5		
Section (marks)	A <sup>SEP</sup> (1)	B <sup>SEP</sup> (3)	C <sup>SEP</sup> (10)	A <sup>SEP</sup> (1)	B <sup>SEP</sup> (3)	C <sup>SEP</sup> (10)	A <sup>SEP</sup> (1)	B <sup>SEP</sup> (3)	C <sup>SEP</sup> (10)	A <sup>SEP</sup> (1)	B <sup>SEP</sup> (3)	C <sup>SEP</sup> (10)
Duration (mins)	20	90	70	20	90	70	20	90	70	20	90	70
Total no. of question	10	5	10	10	5	10	10	5	10	10	5	10
	No of Questions			No of Questions			No of Questions			No of Questions		
Remember	2	1		2	1		1	1		1	1	
Understand	5	3	2	4	1	1	3	2		3	2	
Apply	3	1	6	6	2	6	6	2	8	6	2	8
Analyse			2		1	1			2			2
Evaluate												
Create												

\*No of pages:04

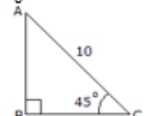



DA:  ROLL N:

NACHIMUTHU POLYTECHNIC COLLEGE, POLLACHI  
III – TERM MECHANICAL ENGINEERING (ME, MES, MSW, TVS)  
CAT – III  
2201 / S201 LR : ENGINEERING MECHANICS

TIME : 3 Hrs MARKS

PART – A  
(15x1=15)

I. Answer all questions:  
Choose and write the correct answer

- Mechanics is the branch of science which deals with the study of (R)  
 a) action of forces on bodies      b) action of gravity on bodies  
 c) action of weight on bodies      d) action of mass on bodies
- Using the basic trigonometric functions, determine the length of side AB of the right triangle. (A)  
  
 a) h = 7.07      b) h = 10      c) h = 5      d) h = 14.14
- If two forces of 3kg and 4kg act at right angles to each other, their resultant force will be equal to (A)  
 a) 7kg      b) 1kg      c) 5kg      d) 1/7kg
- The figure shown below is an example for \_\_\_\_\_ beam. (R)  
  
 a) simply supported      b) cantilever      c) overhanging      d) fixed
- The force of 200 N acts at a point as shown in the figure. Find the moment of this forces about point 'P'. (A)  
  
 a) all Mp = 400 Nm      b) Mp = 400 Nm      c) Mp = 200 Nm      d) Mp = 200 Nm
- The figure shown below is an example for \_\_\_\_\_. (R)  
  
 a) moment      b) couple      c) inertia      d) torque
- The path of the projectile is \_\_\_\_\_. (R)  
 a) hyperbola      b) circle      c) parabola      d) straight line
- A car is moving with a velocity of 20 m/s. The car is brought to rest by applying brakes in 6 seconds. Then the final velocity will be (A)  
 a) 20 m/s      b) 10 m/s      c) 5 m/s      d) zero
- Wheels of a moving car is an example for \_\_\_\_\_. (R)  
 a) Projectile motion      b) General plane motion  
 c) curvilinear motion      d) Parabolic motion

(2)

★ This is an important stage to align assessment of course outcomes and continual improvement using PDCA



# Industry visits and Internships

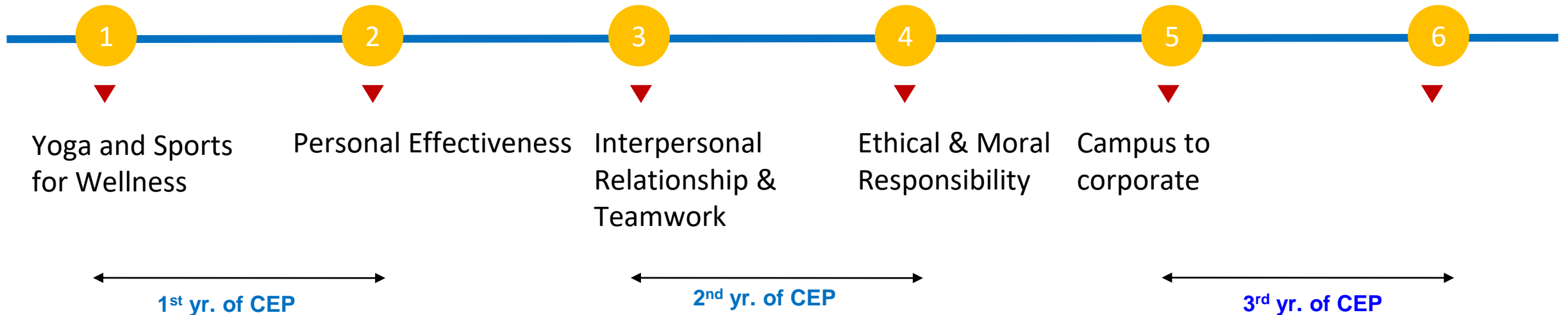
| Hands-on experience

| Connecting theory to practice

What	Who	How	Logistics
Engineering drawing and GD& T	Executive from PED Dept.	<ul style="list-style-type: none"><li>• Explain about the Engineering Drawing practices</li><li>• Explain about the views , GD&amp;T etc</li><li>• Explain about the actual usage of GD&amp;T in design applications</li><li>• QBD about the learning in class and do assignment</li></ul>	<ul style="list-style-type: none"><li>• Classroom with basic requirement (Tables, chairs, white boards, LCD Projector etc)</li></ul>
TPM - Domain Knowledge on Plumbing /Electrical	Manager Workman training - HRD	<ul style="list-style-type: none"><li>• Explain about the importance TPM &amp; its pillars in detail</li><li>• Explain about the JH and its importance</li><li>• Explain about Plumbing /Electrical</li><li>• Qualify all the students Plumbing and Electrical items maintenance.</li><li>• Inform them to maintain the same in Hostel room and Home.</li></ul>	<ul style="list-style-type: none"><li>• Classroom with basic requirement (Tables, chairs, white boards, LCD Projector etc)</li><li>• Availability of Electrical &amp; Plumbing Equipments.</li></ul>
SST Visit	Executive from SST Hosur	<ul style="list-style-type: none"><li>• Explain about the CSRActivities</li><li>• Explain about the Types of CSR Activites followed by TVSM</li><li>• Explain about the Importance of SST</li><li>• Talk about the areas where we help society</li><li>• See the SST activities by a visit</li><li>• Share the feedback to others.</li></ul>	<ul style="list-style-type: none"><li>• Visit to SST for Observation</li></ul>

# Professional & Life Skills Program

- ✦Credit based Professional skills courses
- ✦Daily practice of Yoga and sports; Wellness index based on WHO definition
- ✦Participation in co-curricular & extra-curricular activities





# Snapshots

**Yoga**



(Morning: 5 am to 6am)

**Sports**



**NCC**



**NSS**



**Kitchen Garden**



**Hobby**



# Snapshots

Swachh Bharat



Before



After

Industrial Visit



Learning Forum



Guest Lecture



Arts

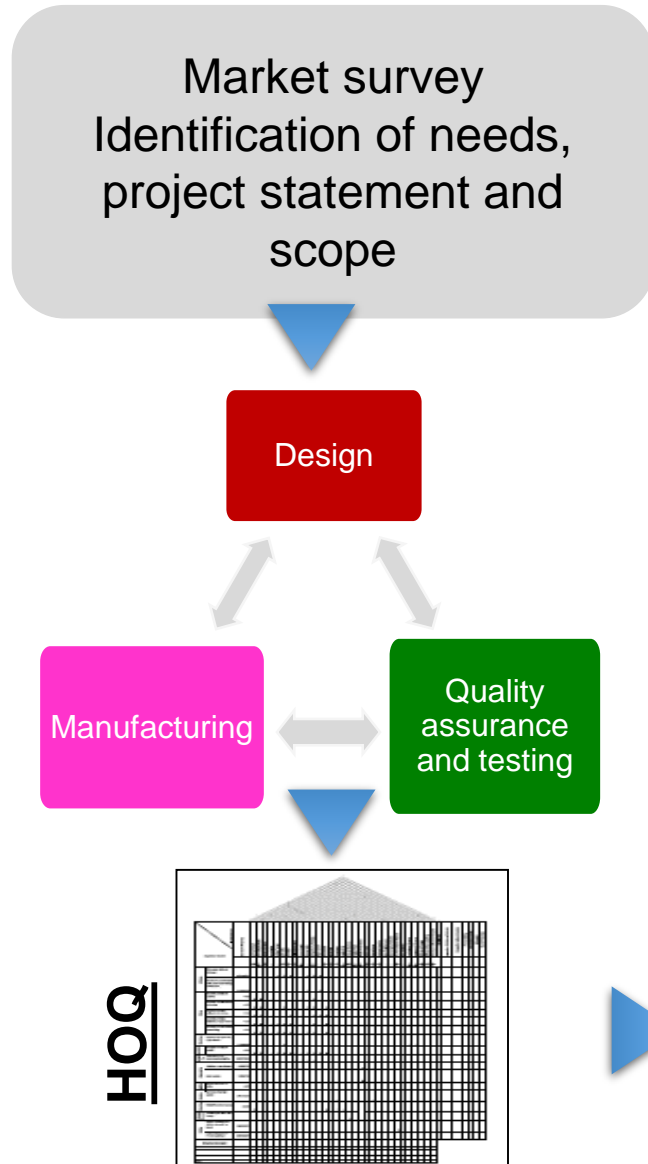


Club Activities

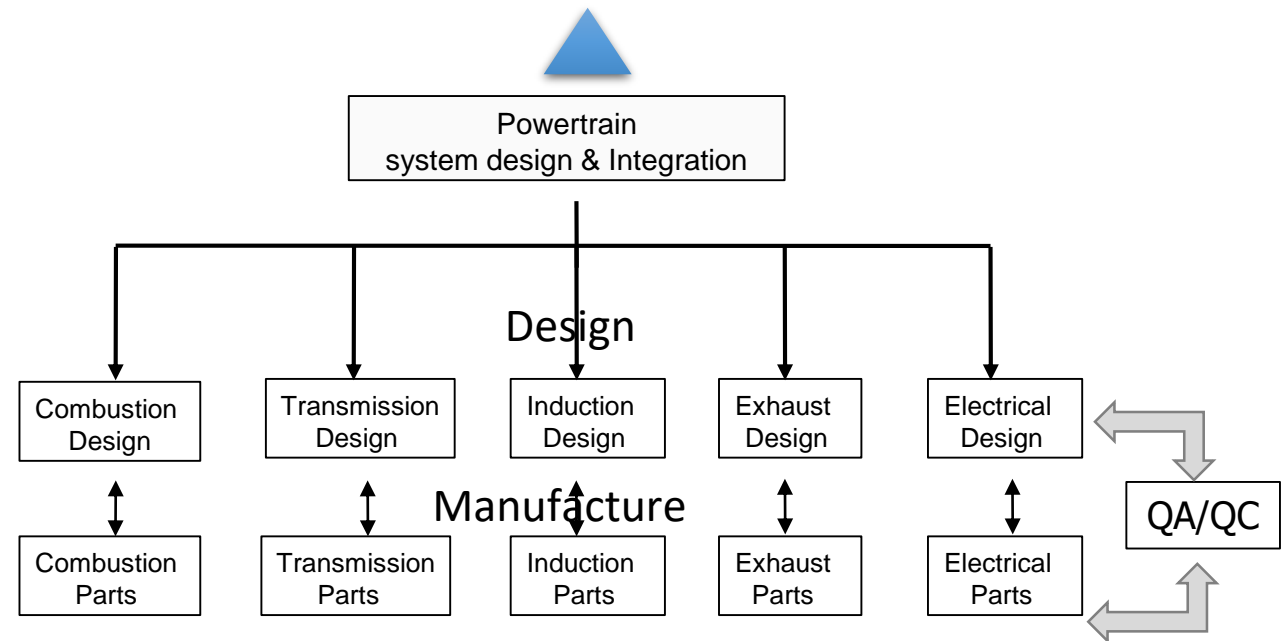




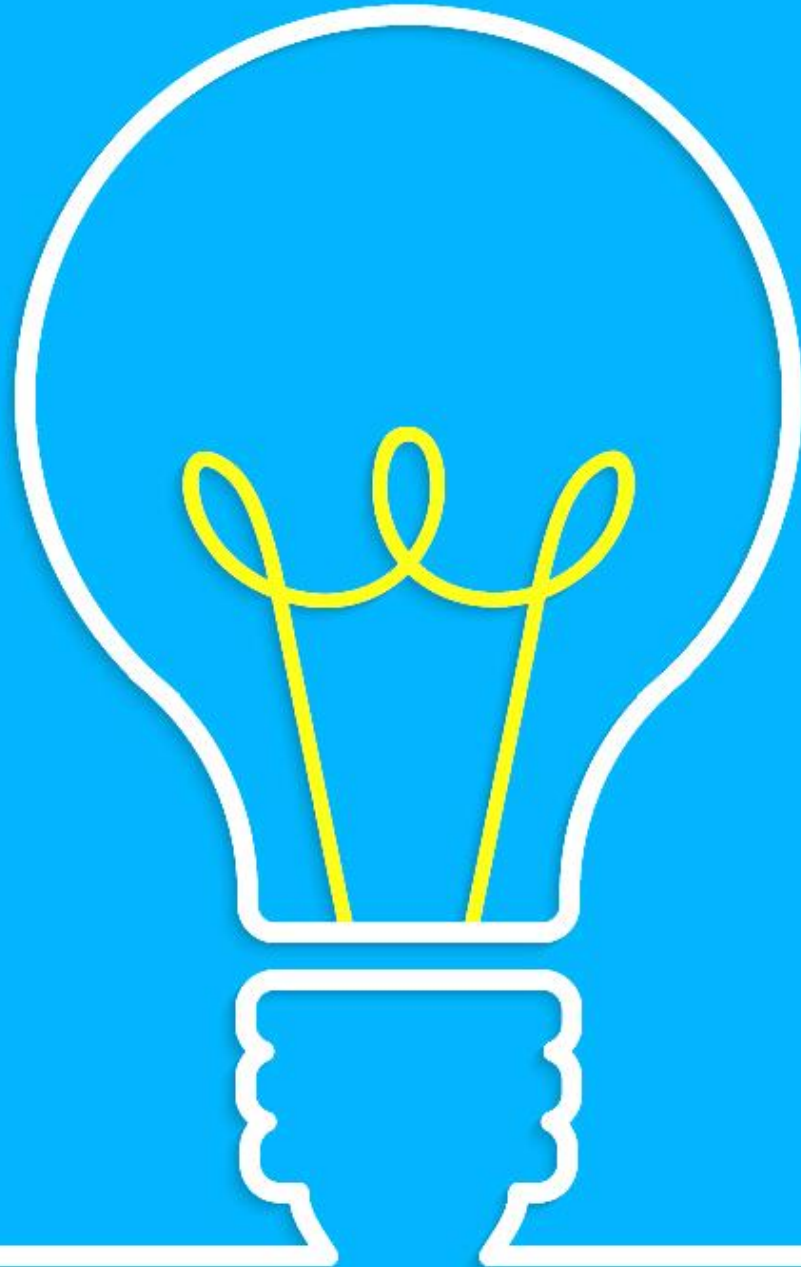
# Industry Sponsored, Collaborative Projects



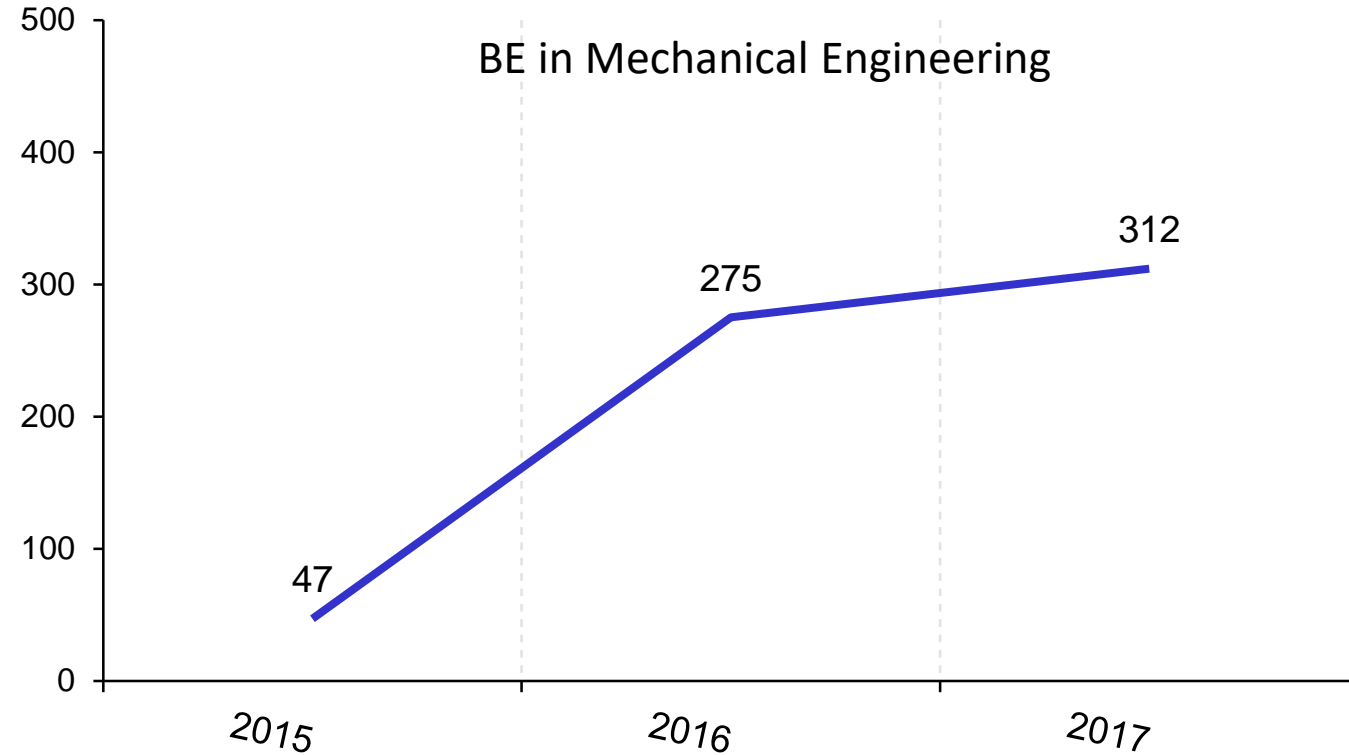
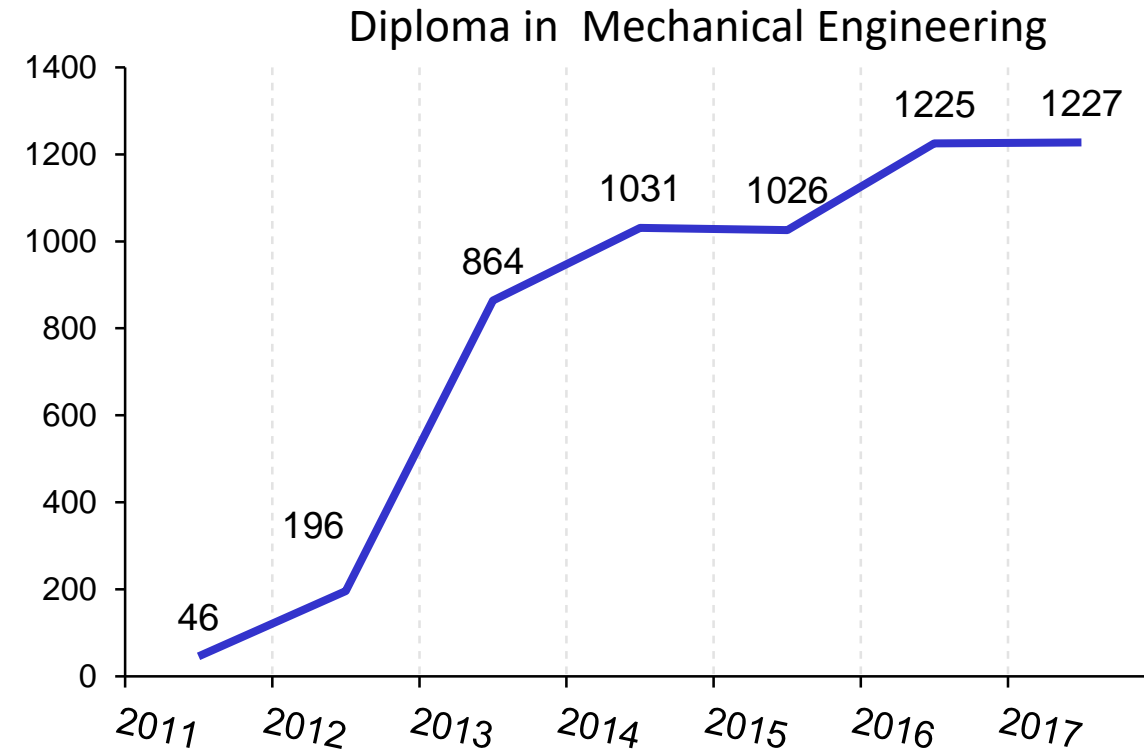
Team	Target	Achieved
Combustion	2kmpl	2.9kmpl
Friction Reduction	10% fmep reduction	14% fmep reduction
Cooling Performance Optimization	1.5kmpl	1.4kmpl
Transmission Improvement	5% Efficiency improvement	6% Efficiency improvement
Overall	5 Kmpl	4.8 Kmpl



**Outcome Impact**

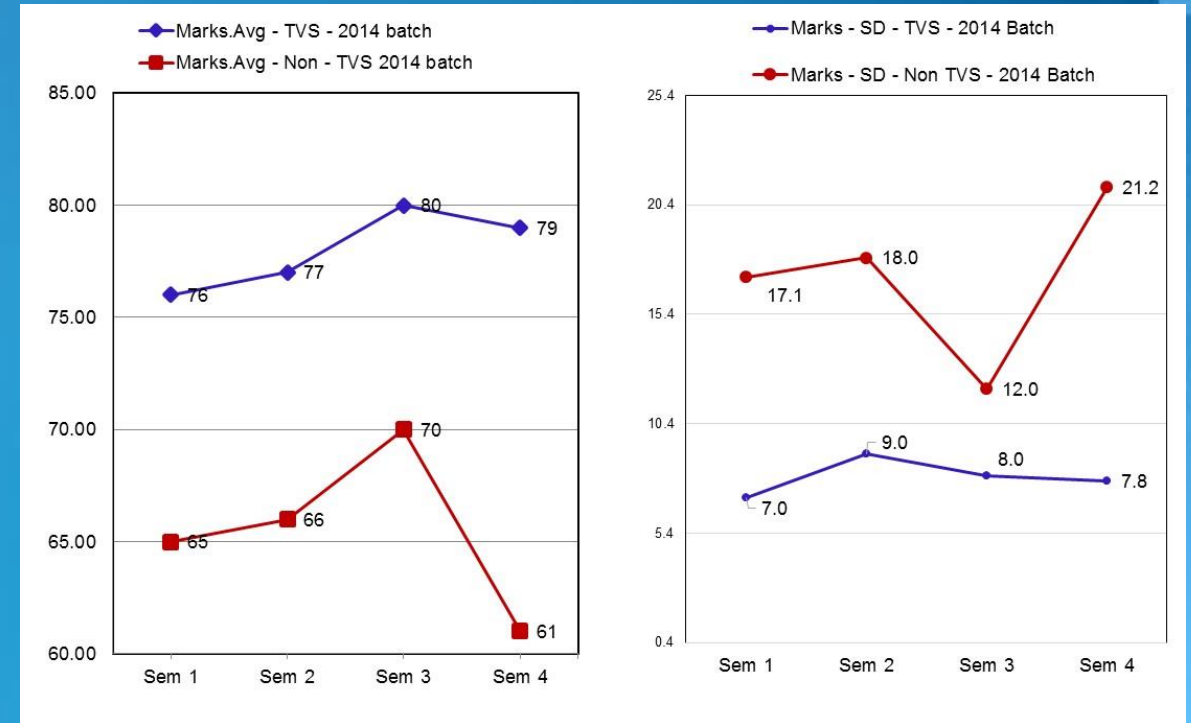
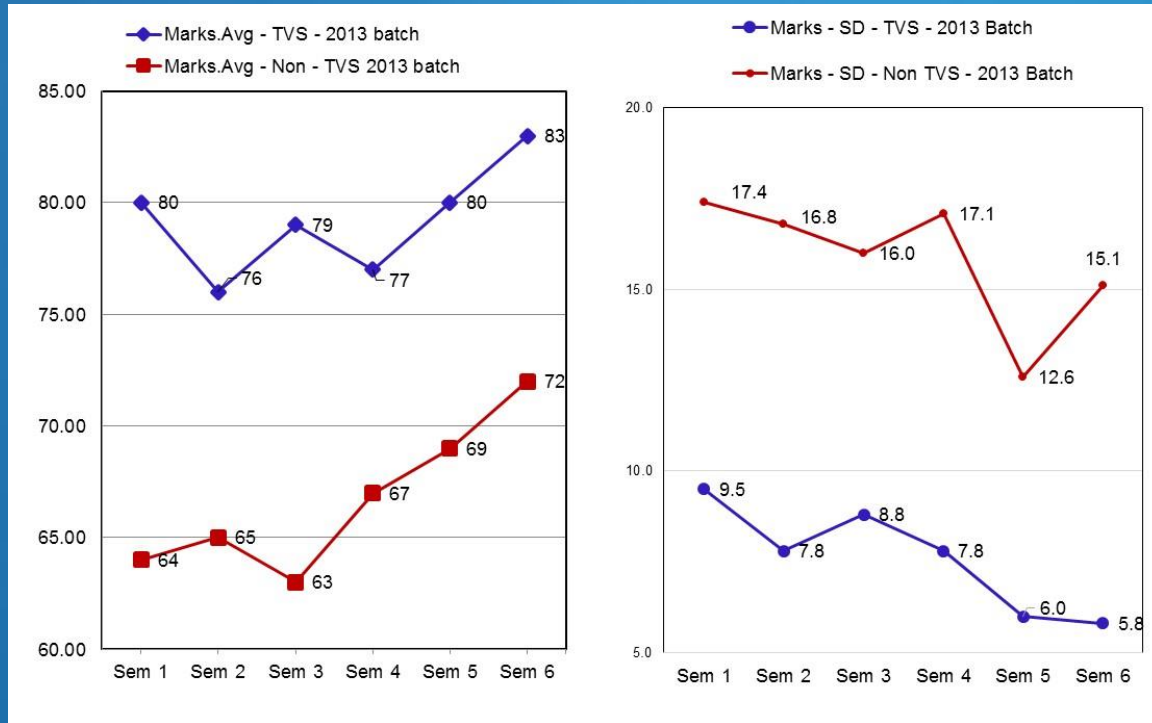


# Technical output: Mobilization





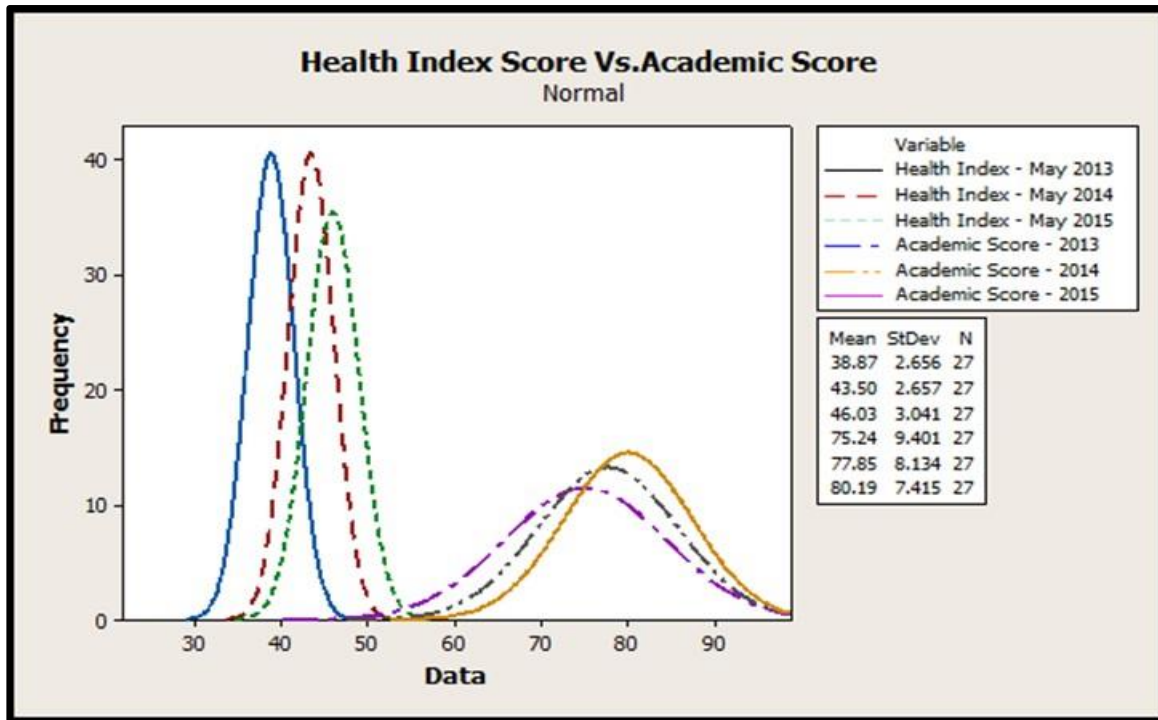
# Technical output: Academic Performance



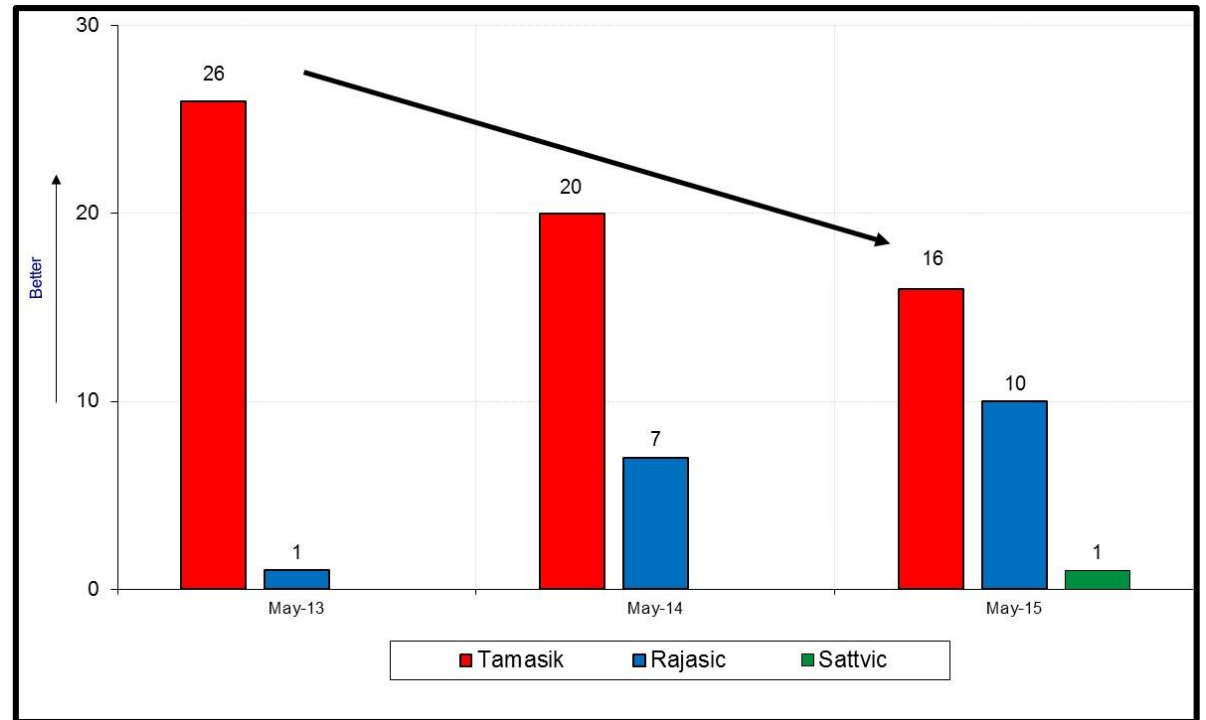
- Mean academic score and Standard Deviation of CEP students is significantly better than peers

# System output: Wellness

## Health Score Vs. Academic Score



## Three Guna's Score



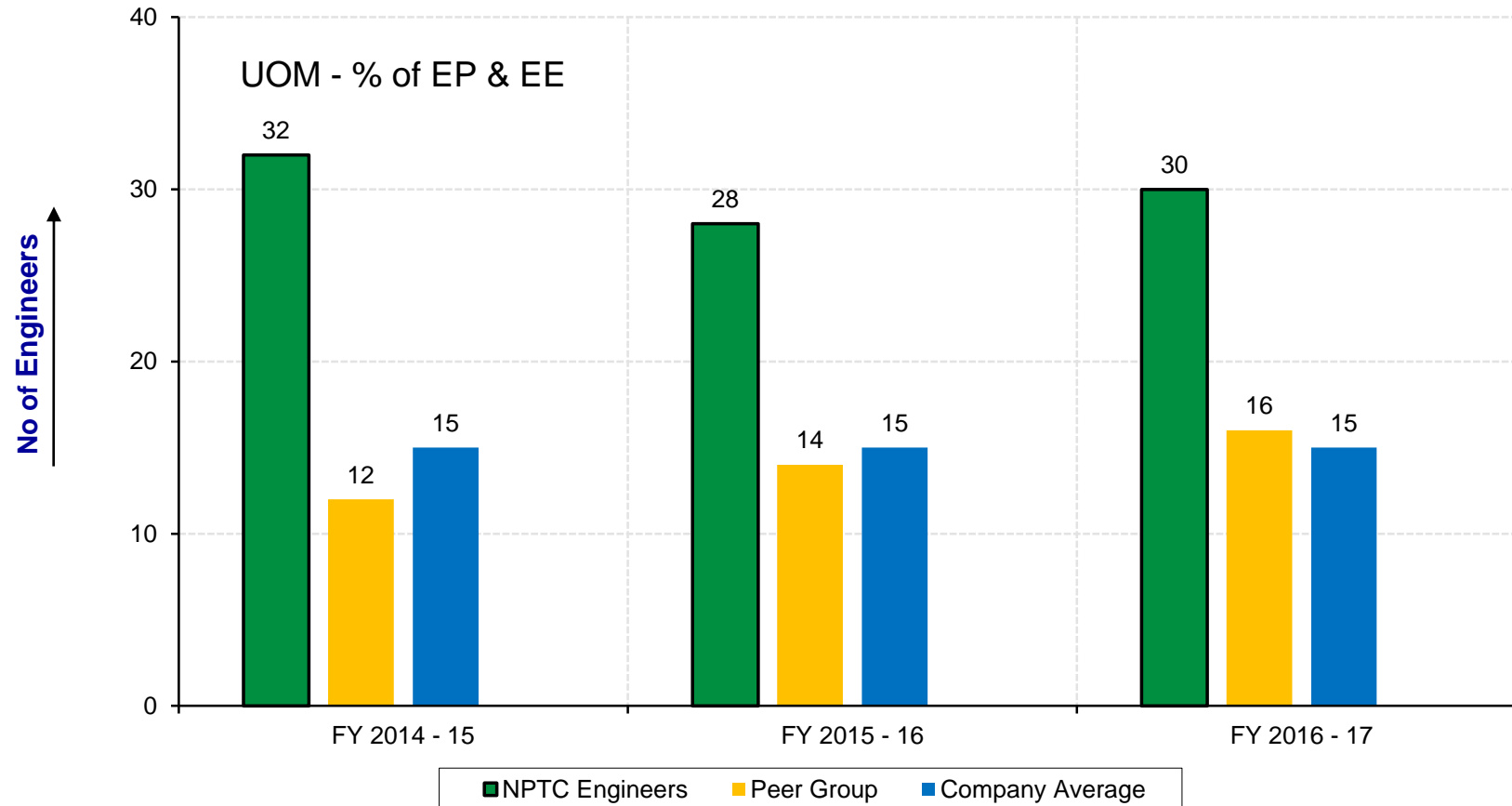
- Steady improvement of Health index and academic performance

# System output: Role readiness

<b>DIPLOMA IN MECHANICAL ENGINEERING (SANDWICH) - 2009 Batch</b> <b>Final Mark Sheet - Role Readiness</b>											
Roll Number	Names	Project Deliverable Achievement (Max 50)	Adherence to Process (Max 25)	Functional Competency Score (Max 25)	Behavioral Assessment Score (Max 25)	Internal Marks(OJT) (Max 25)	Total (Max 150)	Grand Total (100 Marks)	Rank	PASS - first time	PASS - after rework
09MS05	XXX1	47	17	19	22	25	130	87	1	PASS	
09MS27	XXX2	43	21	24	21	20	129	86	2	PASS	
09MS01	XXX3	39	22	20	25	23	128	85	3	PASS	
09MS24	XXX4	44	22	19	21	21	126	84	4	PASS	
09MS12	XXX5	39	22	20	23	22	126	84	5	PASS	
09MS30	XXX6	38	21	18	24	23	123	82	6	PASS	
09MS23	XXX7	37	23	19	23	21	123	82	7	PASS	
09MS20	XXX8	39	21	18	23	22	122	82	8	PASS	
09MS25	XXX9	38	22	18	22	21	122	81	9	PASS	
09MS02	XXX10	37	20	18	23	24	121	81	10	PASS	
09MS03	XXX11	41	17	18	21	21	118	78	11	PASS	

- Formal Qualification of students for specific roles with rigorous assessment

# Performance in the Role



- Proportion of top two performance rating almost twice that of peers
- 63 patents filed by Diploma engineers

# Systems output: Social skills – Flood relief for Cuddalore

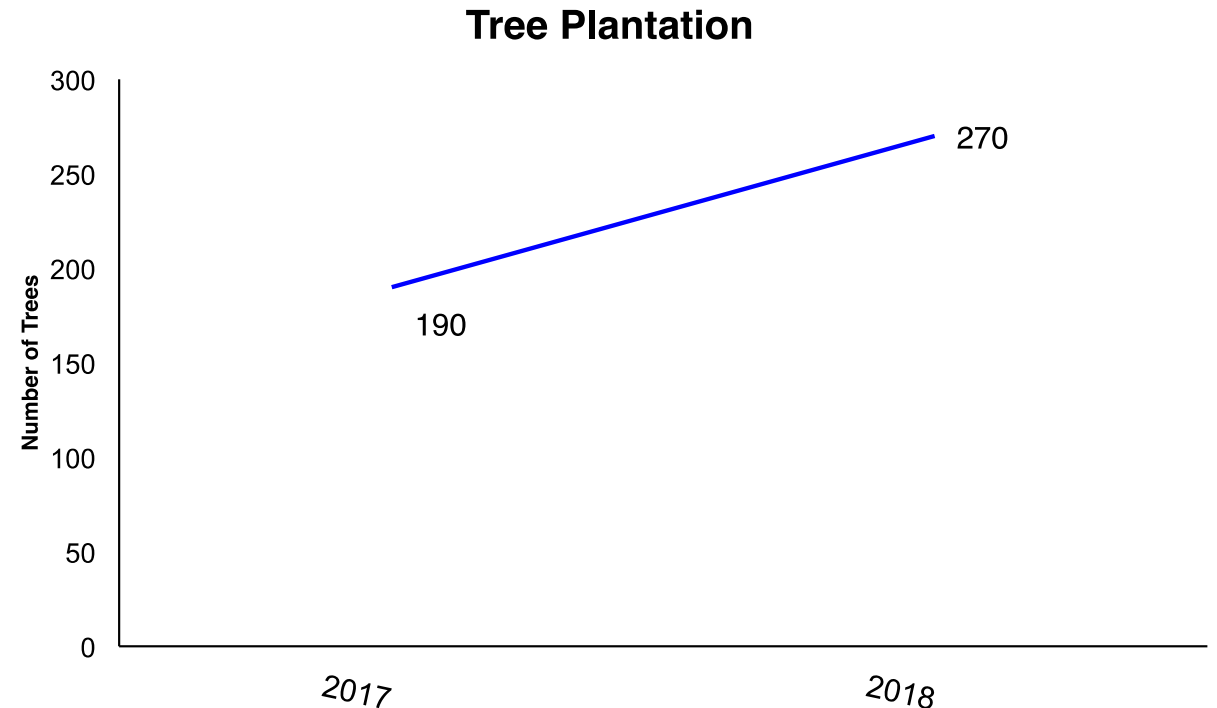
- 60 CEP engineers have contributed Rs 5 Lacs
- 30 of them made three visits to Cuddalore
- Provided relief to victims affected by flood





# Systems output: Social skills – Social skills

- Tree plantation in villages around Hosur
- 70+ Native tree species of India
- Planted in lakes bunds to avoid erosion





## **Systems Approach to Education**



Academic performance  
Wellness  
Engagement  
Life skills  
Role readiness  
Job Performance

It has to be co-created along with stakeholders to make it powerful and meaningful



# Change....



## CHANCE

**Take the first step in  
faith. You don't have  
to see the whole  
staircase, just take  
the first step.**

Martin Luther King Jr.



Thank you

