Developing Progressive Engineering Curriculum for Global Acceptance and Sustainability

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Abstract— **Engineering education of the 21st century demands to be knowledge-based with rich innovation and value creations. On graduation, one should have an engineering career of 40 years. Therefore, learners shall develop the needful KSA and ACM who can not only do the traditional and routine jobs but also give the vision, create new avenues, create new jobs, help the industry to diversify the activities for sustainability, and provide the individual a lifelong career. It demands an evolving curriculum that should not only comply with the university curriculum but also fulfill the needs of the hour by providing flexibility, acceptability, and agility. TCET understands the needs and hence always strives to bring excellence and relevance to the curriculum. Being autonomous from A. Y. 2019-20 onwards, the college has the freedom to design its own curriculum, not only trying to comply with the requirements of affiliated universities but also trying to achieve global excellence in the field of technical education. The revision cycle has been set for three years. The curriculum highlights that practical & practice-based learning, problem & project-based learning, industry & research orientation, and pedagogy supplemented with andragogy & heutagogy have made the curriculum unique. The strategy and approach for curriculum design have not only made the institute achieve various compliances but also made the curriculum evolutionary and well-accepted by stakeholders including industry.**

Keywords— **KSA, Curriculum, NEP 2020, Accreditation, Design and Development (DAD)**

I. CONTEXT

Institute is striving to be one of the premier institutes known globally by offering one of the best curriculums in the country. It meets the needs of the academic (cognitive development), regulatory bodies, industry, student's expectations, and lifelong professional career. Institute is committed to meeting the national and international standards applicable to technical education. With this perspective, the institute offers the curriculum to satisfy the needs of the students to get one of the best professional careers to match students' credentials and abilities.

Regulatory and affiliating bodies set the standards for the curriculum through the model curriculum at the national level and the industry/market set the requirements for the graduates. Therefore, the scope of the curriculum is to set a standards-based sequence of planned learning experiences where students practice and attain proficiency in content and applied learning skills. Proficiency in content is developed through classroom learning, tutorial, and various educational interventions. Educational intervention in the current scenario mainly includes Assignments, Term work, Testing and Examination, Research, Documentation, etc. On the other hand, applied learning skills are through laboratories, workshops, activities, projects, practice, etc. Curriculum under formal education is the central guide for all educators as to what is essential for teaching and learning so that every student has access to rigorous academic experiences. They can be certified for learning based on credits. A rich curriculum looks for various aspects:

- Student centric to support inbox as well as out of box learning.
- Rich component of pedagogy, andragogy, and heutagogy.
- Practical oriented, Industry linked, and Research oriented.
- Support education that is Pragmatic, contemporary, and Futuristic.
- Career oriented with global competitiveness, global mobility, and a Lifelong learning attitude.
- Develops the ability among students to connect the learning dots of past, present, and future for a rewarding career.

The institute needs to adopt the quality journey to make the curriculum progressive and sustain the demand. We need to look for the various aspects in the form of an Educational Qualification Pack (EQP) for the design and development (DAD) of an effective curriculum such as 1. Identification of learning needs under the formal system and its proper

sequencing for effective outcomes. The curriculum profile includes learning fundamentals, core, and application of STEM knowledge supplemented with strong computational, technological, and practicing knowledge. 2. Curriculum shall conformance to the educational framework for activities sequences, regulatory and statutory compliances, educational content, and industry standards for skilled task force etc. Designing and developing curriculum shall focus for the learning ecosystem for effectiveness, application, active participation in educational activities, competitive edge, brighter career on graduation, and capturing if BPIP emerging from the educational activities. 3. Curriculum shall develop the knowledge for intelligence and wisdom viz literary, linguistic, numerical or mathematical, logical, kinesthetic, technical, interpersonal, and naturalistic intelligence. It shall develop practicing skills for competency and mindset development required for doing the job viz academic skills, technical skills, project skills, professional skills, research skills, leadership skills, life skills, and social skills. Learning shall be simplified and to be made experiential by effective usages of pedagogy. Some of the pedagogy may include concept maps, mind map, usage of technology in the TLP, etc which are in addition to traditional one. 4. Syllabus with Credit framework, TLP, Activities, Projects, practice to make traditional education a pragmatic, contemporary, and futuristic education. Various frameworks to support Teaching, Learning, Testing and Examination (T&E), E&A framework, Employability, and certification as a graduate with practicing proficiency. Framework shall support the development of KSA, ACM, and sensitivity for society and concern for the environment. 5. Initially curriculum shall support guided exploration for knowledge acquisition based on Learning, learning experience, learning application. In the later part, curriculum shall promote open ended learning. Knowledge gained through the learning process shall exhibit skills, attributes, ethics and values leading to OBE supplemented with Competency-Based Education (CBE).

II. SCOPE

The curriculum adopted in autonomy shall equip the students with necessary Knowledge, Skill, and Social Sensitivity required for professional career and lifelong learning. TCET follows the AICTE model curriculum for academic conduct [1]. It includes courses and syllabus to be taught over four years with proper sequencing and the credits allocations as per the national standards. This is mainly to ensure that students passing out from TCET shall be engineering graduates as per national and international standards. To meet the professional requirements, TCET has also implemented the POs as per the graduate attributes given by the NBA. The TCET curriculum also includes holistic and multidisciplinary based learning credits in order to incorporate the requirements of NEP 2020 [2]. TCET autonomy curriculum has also aligned with National Credit Framework (NCrF) [6]. For industry readiness and

professional development, the institute has also introduced INTERNSHIP, ESD and PSD credits. The TCET Curriculum is developed in such a way so as to linked with POs and PSOs.

III. OBJECTIVES

The major objectives of effective curriculum development are:

- To design a curriculum that suitable for knowledge development, industry and professional skills, and research aptitude.
- To offer one of the best implementable and widely acceptable curriculums for the sustainability and agility of the programmes irrespective of market conditions.
- To enable the students to develop KSA and ACM based on active education, training, and research within the perspective of the programme.
- To enrich the traditional curriculum with value creation and innovative & interactive content, activities, and practices providing a competitive edge to learners.
- To provide learners multiple platforms for bright global careers with local relevance.

IV. DEVELOPMENT OF BEST PRACTICE

In recent years, there is a major shift in engineering education from content-based learning to outcome-based learning. Under NEP 2020, it needs to be further diversified to competency-based learning [2]. The learning outcome of our students should be reflected in educational event participation, semester performance, academic results, professional certification, R&D work recognition, professional placement, and career growth. To give students more flexibility in learning and at the same time make them globally employable, curriculum delivery shall be promoted through online mode in addition to the traditional approach and hence education must be in the dual of hybrid mode. Looking into these aspects, today's educational qualification pack is prepared for the success of the students in the programme. It is to be profiled as a curriculum with purpose, scope, prerequisite, co-requisite, content, syllabus, activities, application, practices, and career. Curriculum continuous quality development shall be defined as a quality journey as QCVCIM (qualify, compliance, value creation, innovation, and maturity) model. The TCET curriculum not only complies with the UOM as it integrates the activities, internship, industry and research practices under a formal system either with credits or the activity points. The provision and initiatives have brought the better connection of the students with education making learning pragmatic and futuristic. College is putting sincere efforts to meet the requirements of national and international standards and trying the best of the effort to meet industry expectations. Therefore, graduates from the TCET campus have competitive advantages with global agile careers.   The evolution of the curriculum at TCET over the period as an

edition is as follows:

Figure 2: Process diagram for Designing / Revising the
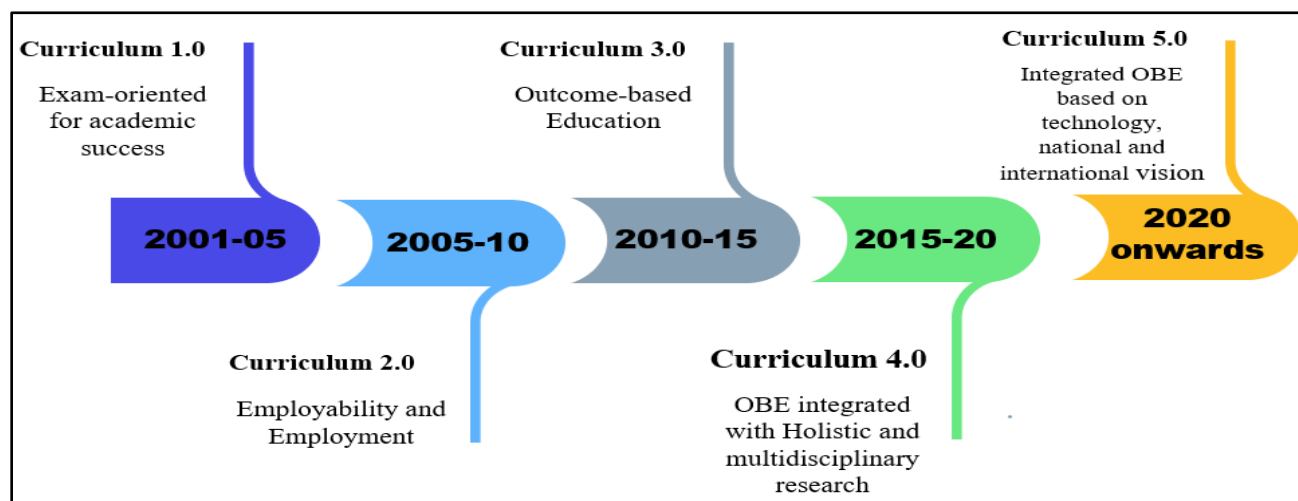
Figure 1: Journey of Curriculum Evolution

A. *Curriculum Finalization and Approval*

The effective curriculum is designed by the pool of subject experts in the department through the consultative process. For the effective design of the curriculum, the subject experts receive inputs from various sources which include advisory, PAC, BOS, academic council, and IQAC Board meetings, comments, and action is taken. AICTE/NBA/UGC/University guidelines prescribed model curriculum, committee reports, audit reports (internal, peer committee, and ISO surveillance audit), and feedback on curriculum from employers, alumni, parents, and students. Syllabus of GATE [3], the syllabus of leading institutions, certification courses, online professional courses, etc. also considered. Fig.1 shows a process diagram of curriculum design.
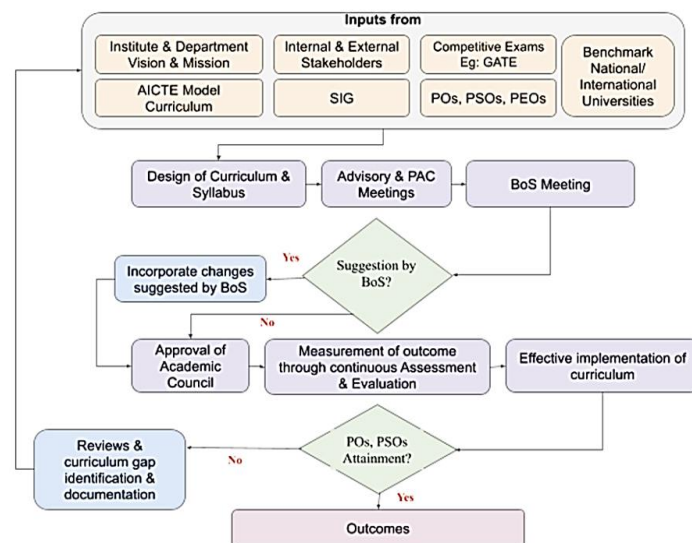
B. *Curriculum Comparison and Details of credits*

Courses under the curriculum are categorized under the various groups as shown in table 1.

Table 1: Curriculum Comparison & Details of credits

| Category	Credits as suggested by AICTE [1]	TCET Credits 2022-23
Humanities and Social, Sciences including, Management courses	12	9
Basic Science courses	25	27
Engineering Science courses including workshop, drawing, basics of electrical / mechanical /computer etc	24	20
Professional Core Courses	48	65
Professional Elective courses relevant to chosen specialization/branch	18	20
Open subjects – Electives from other technical and /or emerging subjects	18	12
Project work, seminar	15	09
Total Academic Credits	160	162
Internship	-	14
Total HSD Credits	-	30
Total Credits	160	206
Major / Minor Courses (Specialization)	-	18
AICTE, 100 Points	-	**100 Points**
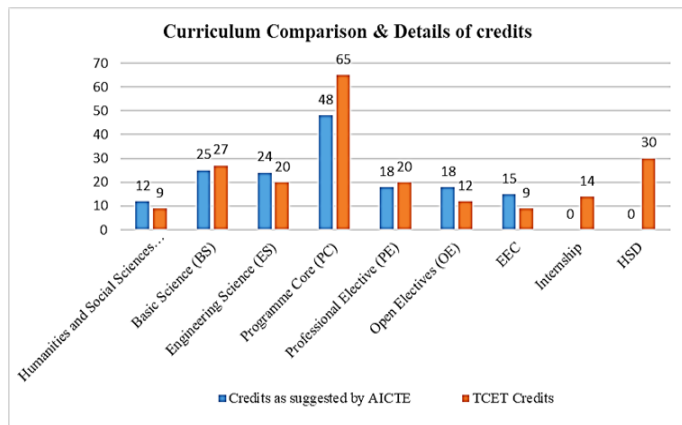
Figure 3: Curriculum comparison and details of credits

V. DEPLOYMENT OF BEST PRACTICES

Curriculum deployed through theory, practicals, and tutorial conducts for a semester. Semester conduct compliance includes 15-18 (typically 16 weeks in a normal course semester) weeks of academic conduct. Students are tested on a continuous basis throughout the semester and at the end of the semester through formative and summative assessments. Testing, Evaluation, Assessment, and result declaration take 5 weeks followed by an INTERNSHIP of 2-3 weeks per semester. The remaining weeks are semester breaks. Institute also conducts the programme level non-credit testing mainly based on competitive examination content. The teaching Learning Process is student-centric and faculty-driven with strong leadership and shall develop the engineering attributes in proportionate with POs and provide a competitive edge to the students. PDCA cycle is followed to bring improvement, value addition, and innovation. **Figure 4** describes curriculum deployment through PDCA.
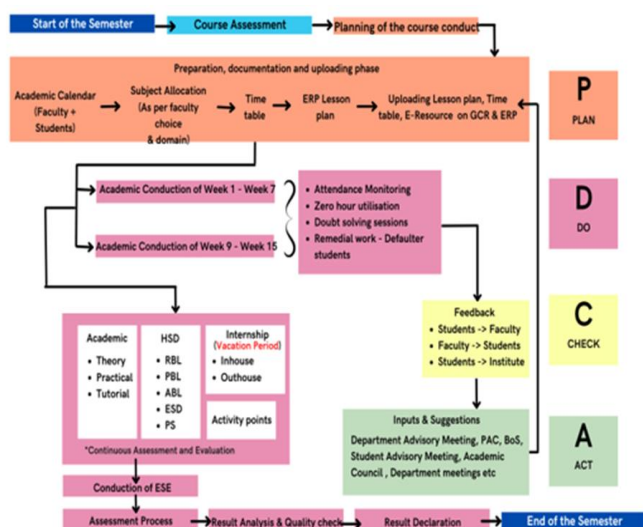

Figure 4: Curriculum deployment through PDCA cycle

VI. MONITORING OF BEST PRACTICES

The curriculum design and implementation are verified, validated and monitored at various levels. For the effective implementation of the curriculum, it is required to be approved by the institute's statutory BOS and academic council and quality is assured by the IQAC and PAC team. There is continuous monitoring for credits, delivery, academic calendar, semester conduct, term grant testing, and E & A for learning verification and validation. Students' performance is measured in formative assessment, term work compliances, the summative assessment for continuous semesters, and End Semester Examinations against the set benchmark. The curriculum is also monitored via students' results w.r.t. to attempt to clear the subjects, class, Graduation Rate, and Success Rate against a set benchmark. Further, students' readiness for a professional career and global mobility. Verification and Validation of Curriculum and Syllabus has shown in **Table 2 and Table 3.**

VII. OBSTACLE FACED / PROBLEMS ENCOUNTERED

- In today's world, the trend in technology changes rapidly, and it is a challenge to integrate all such advancements into the curriculum.
- In order to match the advanced pace of the curriculum, faculty member training is required by Experts in that domain.
- Every stakeholder has a different perspective on embodying changes in the curriculum, but incorporating all the changes is difficult.

VIII. RESOURCES REQUIRED

Resources requirements for effective design and implementation of the curriculum are ICT tools, classrooms, Tutorial rooms, Project rooms, Workshops, Laboratories, Learning resource material, etc. There is the inclusion of recent trends, and technologies in the curriculum to match industry trends with the curriculum, therefore regular faculty training is required. To design effective curriculum inputs are taken from Advisory committee members, BOS members, Programme Assessment Committee (PAC) members, alumni, competitive edge and global career, reputed universities, IITs, NITs, Competitive Examination such as GATE etc.

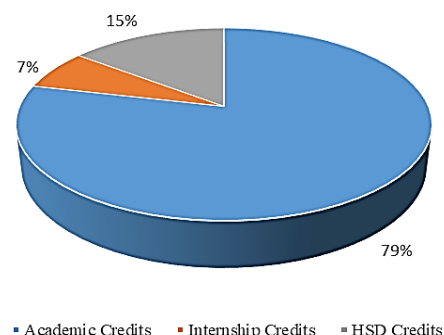**Table 2: Verification of Curriculum and Syllabus**

TCET Autonomous Curriculum	AICTE		National Curriculum			International Curriculum	Usage of Standard Modes	PO/CO PEO	HSD
	Model Curriculum	Exam Reforms	UoM	Competitive Exam-GATE	Curriculum of IIT,NIIT	Model US-IT Curriculum	RBT	Monitoring By PAC	
	✓	✓	✓	✓	✓	✓	✓	✓	✓

Table 3: Validation of curriculum and syllabus

TCET Model Curriculum					
Validation Points / By	Syllabus profiling and structure	Number of credits	Contents	Industry Requirement	Progression to professional Placements, Higher studies, entrepreneurship
BOS	✓	✓	✓	✓	✓
Academic Council	✓	✓	✓	✓	✓
Governing Council	✓	✓	✓	✓	✓

IX. RESULT OF BEST PRACTICE / EXPECTED OUTCOME

Developing a progressive engineering curriculum for global acceptance and sustainability is crucial in preparing future engineers to address the complex global challenges of our time, advancing sustainable development, meeting changing workforce demands, enhancing global competitiveness, and fostering ethical and responsible engineering practices. There is a continual improvement in the curriculum and value creation through networking with stakeholders, active interaction on various platforms, associations, and knowledge management. TCET curriculum is categorized into academic curriculum based on AICTE model syllabus, HSD and summer internship and activity points - Figure 5. All admitted students shall complete the programme as per the graduation period by acquiring credits accepted nationally and internationally. Knowledge, Skills and Attitudes shall be developed as per requirements of graduate attributes and the professional world practiced globally. All students shall be eligible for professional placement and shall excel with a competitive edge and global career.

Figure 5: TCET Curriculum Components

X. CONCLUSION

Curriculum design and implementation is a focused, progressive, and systematic process. The scheme and syllabus shall ensure holistic and multidisciplinary learning to match the requirements of NEP 2020, Technology Vision, and Emerging knowledge in the field of Engineering and Technology. A strong curriculum develops knowledge, Skills, and Attributes and identifies the learning outcomes, standards, and core competencies. There is a need to enhance the curriculum regularly to keep up with the fast-growing technological advances and to address societal needs. To ensure the curriculum is flexible and agile 20% change per course has been recommended by the statutory

bodies. The institute apparently follows a three-year cycle for curriculum revision to meet the slated compliance and ensure concurrency with the industry and professional careers. As a result of the above-mentioned action, the institute is focused to align itself with emerging fields, which has empowered the curriculum to be contemporary yet futuristic.

REFERENCES

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