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A framework for a curriculum to ensure minimum standard for flexible, experiential and multi-disciplinary learning towards achieving NEP-2020 goals

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Abstract:

A well-designed and futuristic educational policy is very much essential for a nation at different levels of education, since good education leads to economic and social progress of a nation. The education systems adopted by different countries differ by considering their own tradition and culture at different education levels to make the system effective. The Government of India recently has announced a new education policy, NEP-2020 based on the recommendations by an expert committee. However, there is a need for a specific plan to realize multi-entry multi-exit, experiential learning and multidisciplinary approach proposed in NEP-2020 for higher education in India, particularly Tier–II institutions. This paper proposes a framework enabling educational institutions to plan and prepare their curriculum ensuring various goals and objectives of NEP-2020. The proposed framework addresses the guidelines for Computer Science and Engineering programme and may be extended to other branches of Engineering.

Keywords: **NEP-2020, Outcome Based Education (OBE), Higher Education Institutes (HEI), Accreditation System, Experiential learning, Performance Ensuring Measures (PEM).**

1. INTRODUCTION

The Education Policy of a nation emphasizes on the development of creative potential of an individual. It is based on the principle that education must develop foundational capabilities of literacy and numeracy, higher-order capabilities, critical thinking and problem solving. It also emphasizes on social, ethical, and emotional capabilities and dispositions. Indian culture and philosophy have been influencing the entire world. These rich legacies must not only be nurtured and preserved but also be enhanced and put to new uses through our education system.

The world is undergoing rapid modifications in the knowledge landscape. With various scientific and technological advancements like – Robotics, Big-data, Machine learning (ML), Artificial Intelligence (AI), Internet of Things (IoT), etc. there will be increased need for a skilled workforce. The skilled workforce requires mathematics, computer science and data science in association with multi-disciplinary abilities across the sciences, social sciences, and humanities.

Hence, Education must migrate towards less content and more experiential learning. In this regard, our education policy must focus on – 'critical thinking and problem solving', 'creativity and multidisciplinary', and 'innovation and adaptability'. Pedagogy must evolve to make education more experiential, integrated, flexible, learner-centred and discussion-based. Education must build character, enable learners to be ethical, rational, compassionate, and caring, while at the same time prepare them for gainful, fulfilling employment [1].

Experiential learning is one of the major components of NEP, but the existing education system focuses more on memorization. There is no uniformity to ensure minimum common learning experience for students handled by different course teachers at different times. Even though experiential learning is practiced to some extent, it is observed in very few courses and done at a marginal level. To fill this gap in the education system, a new approach called *Performance Ensuring Measures* (PEM) is proposed in this paper. This PEM model must be made mandatory for all courses, where each course has a relevant part, focusing on experiential learning.

2. The Institutional Perspective of NEP-2020

The vision of higher education will require a new conceptual perception that constitutes a Higher Education Institution (HEI) i.e., a University / a College. A University includes a multidisciplinary institution of higher learning that offers undergraduate and post-graduate programmes, with high quality teaching, research, and community engagement. The definition of university thus allows a spectrum of institutions as below:

a) *Research-intensive* Universities that emphasizes on research along with teaching.
b) *Teaching-intensive* Universities emphasizes on teaching but still conduct significant research.
c) An *Autonomous degree-granting College* (AC) will refer to a large multidisciplinary institution of higher learning that grants undergraduate degrees, primarily focused on undergraduate teaching.

3. Institutional Progress and Accreditation- NEP-2020

A phase-wise mechanism for granting graded autonomy to colleges through a transparent system of graded accreditation can be established. Colleges can be encouraged, mentored, supported, and incentivized to gradually attain the minimum benchmark required for each level of accreditation.

The quality of education and industry readiness of any graduate is ensured by accreditation process. The major agencies of accreditation include National Board of Accreditation (NBA) and National Assessment and Accreditation Council (NAAC). The major component of these accreditations is- Outcome Based Education (OBE) [2]. The OBE ensures the expected critical thinking levels of every graduate, based on the outcomes defined at course level and also at program level. These are referred as Course Outcomes (COs) and Program Outcomes (POs) [4]. The mapping strategies suggested by NBA are greatly influenced by the evidences to be produced at appropriate level. There is a great level of mismatch between the mapping level written and the type of evidences produced, making attainment of outcomes irrelevant. Therefore this demands a concrete approach towards ensuring experiential learning proposed by NEP-2020.

Over a period of time, it is envisaged that every college would develop into either an Autonomous degree-granting college or a constituent college of a university. In the latter case, it would be a part of the university. With appropriate accreditations, autonomous degree-granting colleges could evolve into research-intensive or teaching-intensive universities. HEIs will have the autonomy and freedom to migrate gradually from one category to another, based on their plans, actions, and effectiveness.

4. Challenges and Issues in Higher Education

Some of the major problems currently faced by the higher education system in India as specified in NEP-2020 Policy manual are as listed below [1]:

a) A severely fragmented higher educational ecosystem.
b) Less emphasis on the development of cognitive skills and learning outcomes.
c) A rigid separation of disciplines, with early specialization and streaming of students into narrow areas of study.
d) Limited access, particularly in socio-economically disadvantaged areas, with few HEIs that teach in local languages.
e) Limited teacher and institutional autonomy.
f) Inadequate mechanisms for merit-based career management and progression of faculty and institutional leaders.
g) Lesser emphasis on research at most universities and colleges and lack of competitive peer reviewed research funding across disciplines.
h) Suboptimal governance and leadership of HEIs.
i) An ineffective regulatory system; and
j) Large affiliating universities resulting in low standards of undergraduate education.

In order to handle some of these issues effectively the authors have proposed a strategy by taking Computer Science and Engineering program as a case study.

5. Proposed Strategy

There is a need for a specific plan to realize multi-entry multi-exit, experiential learning and multidisciplinary approach proposed in NEP-2020 for higher education in India, particularly Tier –II institutions. The framework proposed here enables an educational institution to plan and prepare their curriculum ensuring various goals and objectives of NEP-2020. The proposed framework addresses the guidelines for Computer Science and Engineering programme and may be extended to other branches of Engineering.

The major perspectives addressed in the proposed framework include the following:

a) Multi-Entry Multi-Exit (MEME)
b) Credit Bank
c) Experiential Learning
d) Multidisciplinary approach
e) Quality Standards
f) Flexibility for Students, and faculty under autonomy

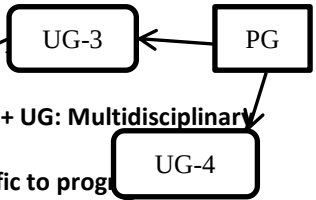
5.1 Multi-Entry and Multi-Exit (MEME)

The new National Education Policy proposes to make the 3-year/4-year undergraduate program of the bachelor's degree allowing students to have their own pace of learning

in an incremental approach. Each phase in incremental learning is awarded with appropriate degree, enabling them to work in society and at later stage continue their learning if required. Depending on the duration of their study, they will be awarded a certificate, a diploma degree, 3 years bachelor's degree, 4 years bachelor's degree and/or a master's degree. Students can get a basic certificate after a 1-year program, an advanced diploma after 2 years, a Bachelor's degree after 3 years, and a Bachelor's with research after 4 years. It also provides a provision for a student to drop the course and resume it as per the convenience.

On the other hand, educational institutions are likely to face a lot of challenges while implementing the MEME. One of the main problems would be determining the number of students to be admitted each year. Implementation of MEME may result in a distorted educational experience if not tracked properly. The strategy proposed by the authors in implementing MEME considering Computer Science and Engineering as a case study is shown in Figure-1.

Multi Entry:
With Common Learning equivalence approved by statutory bodies / Institutional Bodies.
Multi exit: - *exigent condition/ Incremental Learning*
After 1st year - Basic Certificate **+ Project**
[CSE: Programmer-Beginner/ **Basic C and Advanced C-Audit course on C++& Python**]
After 2nd year - Diploma Degree**+ Project**
[CSE: Business Application Developer / **MATHS-1/2, DMS & Graph Theory**, **Digital Electronics**, **Data Structure, Algorithms, Java ,DBMS, Web Technology, Software Engineering, Operating System/UNIX, Computer Network-1**]
After 3rd year- Bachelor's Degree.+ **EPIC/System Project**
core courses enables learning of elective courses
[CSE: System Engineer/ **Probability Statistics and Queuing, Object Oriented Modeling and Design, Computer Architecture, Network-2, Data Science, Cloud Computing, Distributed System, AI and ML, N/I Security, Block chain Technology, IOT,**]
After 4th year – Multidisciplinary Bachelor's Degree+ **Research** Project
[CSE: System Engineer-Expert/
1st Sem :
UG-1: Research Project (IPR) + UG: Multidisciplinary Course- CIE & POE
PG-1: Trending Courses specific to prog
UG-2: Internship/ Project and Independent study (research/Certification)
PG-2 : Research Project (IPR)
After 5th Year - Post graduate degree
[CSE: Advanced System Engineer/ Researcher -Expert]



PG-1: Trending Courses Specific to program
PG-2: Internship/ System Development/ research publication

Figure-1: Proposed Multi Entry and Multi Exit plan

Multi-Entry feature may be implemented with some common learning equivalence approved by statutory bodies like Common Entrance Examination- CET at 1st semester level and institutional bodies like Department Undergraduate or Postgraduate Committee (DUGC/ DPGC) at later stages.

Multi-Exit may be implemented only under some exigent condition, leading to incremental learning at convenient pace of a learner. Every exit point must ensure that students acquire appropriate skills which enable them to get appropriate employment in the society. There are five connected exit points in the proposed framework as described below.

Exit after first year: If a student leaves the course after completing one year then the student gets a basic certificate. The curriculum must be designed in such a way that the student must get the job based on the skills acquired. The proposed job profiles after 1st year exit can be computer programmer-beginner, data entry operator, system administrator. To prepare the students towards this, the curriculum must include the exposure to programming languages like basic C and advanced C, skill-enabled learning like installation and administration of the computer, exposure to MS-office tools, along with other courses like mathematics, physics and chemistry that enable them to go to the next stage with engineering focus. Audit courses or vocational courses on advanced subjects like C++ and Python may be introduced to further strengthen their industry acceptance as a programmer. These are highly contextually relevant and dynamically change based on industry trends. Students must undertake a project in a group in every year to get an exposure on solving real life problems enabling them for industry readiness.

Exit after second year: If a student leaves after second year, then Diploma degree will be awarded. The curriculum should be designed so that the student may be recruited as business application developer.

Few suggested core courses in Computer Science and Engineering stream to enable students to take up a job of business application developer include: Mathematics, Discrete Mathematical Structures, Graph Theory, Digital Electronics, Data Structures, Algorithms, Java, Database Management Systems, Web Technologies, Software Engineering, Operating System and Computer Networks, etc.

Exit after third year: If a student leaves after third year, then the student will be awarded with a bachelor's degree enabling them to work as Systems Engineer.

Few suggested core courses in Computer Science and Engineering stream to enable students to take up a job of Systems engineer include: Probability Statistics and Queuing, Object Oriented Modelling and Design, Computer Architecture, Advanced Computer Networks, Data Science, Cloud Computing, Distributed Systems, AI and ML, Security, Block chain Technology, IOT, etc.

After 4th year: After successful completion of the fourth year, student will be awarded with a Bachelor's Degree with focus on research capabilities and multi-disciplinary learning. Research capabilities are ensured by rigorous research project in their major areas of study. Students may opt for multidisciplinary courses across the sciences, social sciences, fine arts, humanities, and sports in order to ensure the all-round development enabling to work at systems level rather than limiting them at programming alone. Students have to undergo internship to get industry exposure; do research project and certification as a part of independent study during eighth semester. In the independent study course, students are free to choose any course which they have not studied in their curriculum. Students are free to design their course contents and evaluation method which enables the students to be an independent and lifelong learner.

After 5th Year: Students will be awarded with post graduate degree after successful completion of fifth year. At this stage students are ready to take up a job as Advanced Systems Engineer or Research expert. Trending courses specific to program may be introduced in the first semester of 5th year and during the second semester of 5th year, students may go for internship or carry out project work, leading to system development or a research work leading to publications.

Students who complete 3rd year level of bachelor's degree and wish to do post graduate degree have to undergo two semesters of PG program as indicated in Figure-1. On the contrary, students completing 4-year degree program will take only one year of post-graduation and therefore the 4th year of bachelor's degree is designed as common to both post graduate program and under graduate program.

5.2 Credit Bank:

Academic Bank of Credits (ABC) is a mechanism proposed as a digital/virtual/online entity driven by Unique Identification Authority of India [1]. This is to be established and managed by Ministry of Education (MOE) / University Grants Commission (UGC), to facilitate students to become its academic account holders and, paving the way for seamless student mobility between or within degree-granting Higher Education Institutions (HEIs) through a formal system of credit recognition, credit accumulation, credit transfers and credit redemption to promote distributed and flexible teaching-learning.

5.3 Experiential Learning:

OBE is the education philosophy that focuses on ensuring quality of learning through defined course outcomes and program outcomes.

Though, outcomes capture intended learning with focused critical thinking based on bloom's taxonomy, it fails in the expected transformation of graduate quality. This is because of improper planning of course assignments that must comply with the learning intents expressed in terms of course outcomes. The evidences produced by course teacher may not have relevance with the intended mapping level between course outcomes and program outcomes. Under such situations, attainment of outcomes may be merely a number and do not reflect the quality of a graduate. Therefore, industry relevance of a graduate has remained as a major matter of concern.

It is necessary to mention in the syllabus the experiential learning components that every student must accomplish as a mandatory requirement of completion of a course. This will also ensure that every course teacher will drive the course at minimum standard defined by the department. However, course teachers are free to drive the learning activities above this minimum standard.

This approach of mentioning experiential learning component for every course in their syllabus is named as Performance Ensuring Measures- PEM. A sample PEM based syllabus is given at the end of this paper in Annexure[3] and snapshot of experiential component is shown in Figure-2.

1. **Class test / Quiz-(CO-2)**
2. **Written test**- CIE/SEE. **(CO-2)**
3. **CTA-Writing programs** to demonstrate synchronization issues and solutions using p-thread libraries **(CO-3)**
4. **CTA- Group Activity**: **Course project(CO-8)**
   Design and implementation of
   protocols using RFCs / Sockets

Figure-2: Snapshot of part of PEM based syllabus model

This will ensure and highlight the experiential learning aspect of any course and is common to all teachers teaching at different divisions.

5.4 Multidisciplinary approach:

The overall credits of a course in Undergraduate level can be distributed in a ratio of 3:1 among program-specific and generic/multidisciplinary respectively as shown in Figure-3. The program-specific includes Program Core (PC), Basic Science (BS) and Program Core Electives (PCE). The Generic courses include Skill Enabled Learning (SEL) and can be categorized as – Institutional Core (IC) like Professional English, Aptitude, Soft Skills, etc., Institutional Electives (IE) like Music, Foreign languages, History from Scientific and Engineering Perspective, etc., and Program Open Electives (POE) including courses from other Engineering disciplines.

The course distribution in multi-disciplinary approach at 1st year level, both for IT, and Non-IT branches is as shown in the Figure-4 and Figure-5 respectively.

Total: 175 Cr.
1st Semester- 42 Cr
3rd to 8th Semester learning distribution: 133 Cr
175 Cr distribution: as below
Program Specific----------75%
50% **PC**- Program Core 05% **BS** – Basic Science
20 % **PCE**-Program Core Electives
Multi-Discipline----------25%
05 % **IC**- Institutional Core: Soft skills, Professional English Aptitude, etc. (2Cr courses)
05 % **IE**- Institutional Electives : Social science, Foreign Languages- French, German, Japanese; Law, Business Management, Music, Vedic Mathematics, History from Scientific and Engineering perspective etc. (2Cr courses)
15% **POE**- Program Open Electives
Other Engineering disciplines (3Cr courses)

Common admission to college at 1st year level and Selection of branch at 2nd year based on 1st year performance and their choice. – **Government should approve this.** Make branch specific divisions @ 1st Year. **Not** branch specific course from 1st SEM.

Figure-3: Credit distribution in multidisciplinary approach

@ 1st Year Level: 22 Cr + 20 Cr = 42 Cr.		
Branch	**1st Sem**	**2nd Sem**
IT	Maths- 4 Cr	Maths- 4 Cr
	Computer Programming. 3-0-6 = 6 Cr	**Computer programming With Project 3-0-6** = 6 Cr
	Aptitude and Soft Skills. 2 Cr	English(Technical Report Writing and Presentation Skills) 2 Cr
	Physics- IT 3-0-2= 4 Cr	Chemistry- IT 3-0-2 = 4 Cr
	Foundation Course in Core Engineering. with Lab 3-0-6 = 6 Cr	Multi-disciplinary Engineering. 3Cr
		SEL-Skill Enabled Learning- 2-0-2 =3cr Ex: Installation and administration / MS office

Figure-4: Course distribution for IT branches at 1st Year level

5.5 Quality Standards:

The education quality and standards can be achieved by applying the following at an HEI:

a) Strengthening OBE by including well-defined learning outcomes, activity-based learning, inter-disciplinary projects, evidence-based thinking.
b) Well-defined Strategic plan based budget procurement and performance of the institution.
c) A strong Internal Quality Assurance Cell (IQAC) can be constituted at a HEI. The IQAC undertakes introduction of quality process, regular academic audits, and accreditation process, etc.
d) Establishing digital studio and data storage facility for e-contents creation.
e) Creation of central facilities for advanced areas like: Robotics, Human Computer Interface (HCI), High Performance Computing, etc.
f) Networking with High performing Institutions in India and Abroad.
g) Industry Connectivity: Sabbatical leave of 6 months at a stretch in block period of 5 years.
h) 8th semester has to be dedicated for project and Internship only.
i) Encouraging Engineering Projects in Community-services (EPIC).
j) More emphasis on Experiential-learning based assessment rather than conventional assessments.

@ 1st Year Level: 22 Cr + 20 Cr = 42 Cr.		
Branch	**1st Sem**	**2nd Sem**
Non-IT	Maths – 4 Cr	Maths- 4 Cr

	Computer Programming With Lab **3-0-6** = 6 Cr	**Computer Programming With Project** **3-0-6** = 6 Cr
	English (Technical Report Writing and Presentation Skills) 2 Cr	Aptitude and Soft Skills. 2 Cr
	Chemistry- Non-IT 3-0-2= 4 Cr	Physics- Non- IT 3-0-2= 4 Cr
	Foundation Course in Core Engineering with Lab **3-0-6** = 6 Cr	**Multi-disciplinary Engineering.**
		SEL- Skill Enabled Learning- 2-0-2 =3cr

Figure-5: Course distribution for Non-IT branches at 1st Year level

5.6 Flexibility for Students:

Flexibility for students is made sure through MEME, maintaining a common elective pool and through flexible Drop / Withdraw process for a particular course. The sample course distribution is as shown in Figure-6.

The students can opt continuing the education at local institutes through the MEME to revise their previous learning and to maintain the current pace. This helps during many learning gaps created due to Pandemic situations and other natural calamities. The students may opt to take up the vocational classes to cope up with the course requirements. The students are also given access to the e-content uploaded by the faculty for all courses.

Common **pool of electives: Common Institutional Electives and Program Open Electives and Program Core Electives----------**
45% **PC**- Program Core. 05% **BS** – Basic Science
20 % **PCE**-Program Core Electives
Multi-Discipline ----------30%
05 % **IC**- Institutional Core: Soft skills, Professional English, Aptitude, etc. (2Cr courses)
10 % **IE**- Institutional Electives : Social science, Foreign Languages- French, German, Japanese; Law, Business Management, Music, Vedic Mathematics, History from Scientific and Engineering perspective etc. (2Cr courses)
15% **POE**- Program Open Electives
Other Engineering disciplines. (3Cr courses)

- Choice based credits→ **PC**, **PCE and POE with prerequisites**. Min and Max credit registration for each semester. Within a course: **dro**p and **withdrawal** of registration to continue. **No deadline** for program completion due to multi entry criteria at any time.

Figure-6: Overall course distribution

5.7 Faculty Autonomy:

Academic autonomy to the faculty can be ascertained through the following practices:

a) All exams are to be conducted by course teachers as per common time table at Institute level.
b) Answer scripts to be evaluated by course teachers and grade list will be sent to Controller of Examination (CoE) through DUGC.
c) Any variations in assessment tool [type and format] are permitted with the approval of DUGC and Dean Academic program/ Principal.

6. Conclusion

The focus of NEP in terms of experiential learning, MEME, and critical thinking are not seen fully implemented in current system. Though implemented, not followed uniformly among different course teachers at different times. The proposed framework ensures minimum learning standards and also focuses on flexible environment for multi-disciplinary approach enabling autonomy to be implemented in true sense. However, its implementation has lot many challenges influenced by local conditions in various institutes. NEP based curriculum and associated assessment tools and procedures must be designed based on the proposed framework. It does not correlate with any of the existing curriculum.

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