VIDYA JYOTHI INSTITUTE OF TECHNOLOGY

(An Autonomous Institution)

NAAC Sponsored

TWO DAY NATIONAL SEMINAR

ON

QUALITY IMPROVEMENT IN TECHNICAL EDUCATION THROUGH OUTCOME BASED EDUCATION

On

14th & 15th December 2018

Organized by

Internal Quality Assurance Cell (IQAC)

NAAC Sponsored two days National Seminar on Quality Improvement in Technical Education through Outcome Based Education on 14th -15th December 2018

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NAAC Sponsored two days National Seminar on Quality Improvement in Technical Education through Outcome Based Education on 14th -15th December 2018

Theme of the Seminar

The adoption of OBE at engineering institution is considered to be a great step forward for higher education in India but actual success lies in the effective adoption and stringent accreditation process to ensure the quality of education is maintained. Therefore as engineering educators our roles become more diversified. The aim is now to produce global engineers with emphasis on transferable skills. At the same time, we have to be aware that the current generation, Gen Z, is different from previous generations. Therefore, teaching methods and evaluation strategies have to be adapted to the changing needs of the youth. Teaching and research need to go hand-in-hand and have to be inclusive of social and environmental awareness. The traditional classroom set-up is fast being replaced by methods that encourage greater participation and interaction between the students and the teachers. The pedagogical fraternity needs to be committed to engage students in active, collaborative and technology based learning methodologies to develop formative and summative assessments of student progress and learning. Educators at all levels need, personally and professionally, to take on the vital task of equipping students and scholars to face every challenge and use every opportunity as they become effective and productive global citizens and leaders of tomorrow. Hence, quality education is becoming the need of the hour. Quality in higher education is the most urgent need as India moves towards becoming an educational hub. In view of above, the Internal Quality Assurance Cell (IQAC) of Vidya Jyothi Institute of Technology (Autonomous) organized the two days National Seminar with the objectives as follows,

- Defining PEO'S/PSOs and COs, Mapping of COs to POs/PSOs, together with the strength of mapping and defining assessments that justify the mapping, Overall PEO Attainment.
- Learning objectives of course and question paper setting as per blooms taxonomy.
- Teaching Learning and Evaluation: Tools and handle larger class rooms and quicker way of students as well as faculty evaluation
- Best Practices and Case Studies in Teaching and Learning to enhance Quality of Engineering Education

NAAC Sponsored two days National Seminar on Quality Improvement in Technical Education through Outcome Based Education on 14th -15th December 2018

Program schedule

Day – 1 (14th Dec 2018, Friday)

10:00 to 10:30	Inauguration
Resource Person:	**Dr. B Kanmani**, Dean-Academics, Professor, BMS College of Engineering, Bangalore
Session – 1 A	**Topics**
10:30 to 11:30 AM	Introduction to OBE Distinguishing between PEOs, POs, PSOs and COs
11:30 to 1:00 PM	Defining PEO'S/PSOs and COs, Mapping of COs to POs/PSOs, together with the strength of mapping and defining assessments that justify the mapping, Overall PEO Attainment
1:00 to 1:45 PM	Lunch Break
1:45 to 3.15 PM	Computing the attainment of COs, POs/PSOs, using direct and indirect tools
3.15 to 3.30 PM	Tea Break
3.30 to 5.00 PM	Curriculum Design Continuous improvement through the attainment

Resource Person:	**Dr. Madhuri Mavinkurve** ET Practioner & Trainer, Mumbai
Session – 1 B	**Topics**
10:30 to 11:30 AM	*Outcome Based Education* The session will introduce the need for writing course outcomes and assessment questions mapped to these outcomes. It will then start off with how to achieve this outcome based education.
11:30 to 1:00 PM	Design Question bank for their course to attain OBE (Hands-on activity) In this session, the objective will be discussing how to write assessment questions such that they are mapped to the learning objectives teachers had already written
1:00 to 1:45 PM	Lunch Break
1:45 to 3 PM	Blueprint design based on course outcomes and Revised Bloom's taxonomy In this session, the objective will be to introduce the concept of Blueprint design. The session will also discuss how to design this Blueprint of assessment questions to achieve outcome based education
3.15 to 3.30 PM	Tea Break
3.30 to 5.00 PM	Design of Question paper based on OBE alignment. Finally OBE based question paper by teachers

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Program schedule

Day – 2 (15th Dec 2018, Saturday)

Resource Person**: Dr RanjithRamdurai**, Associate Professor & Head of the Department of Engineering Science, IIT Hyderabad	
Session	**Topics**
1 10:00 to 11:30 AM	Teaching and learning methods – Peer Instruction The session will give a brief on various teaching learning methods and would focus on the benefits of peer instruction and methodology involved
2 11:30 to 1:00 PM	Evaluation / Self-assessment of lectures in OBE This session will brief on online free tools that are available for assessment of students and identification of concepts that have not reached efficiently to the students
1:00 to 1:45 PM	Lunch Break
Resource Person: **Dr. B. V. Appa Rao**, Research Fellow (Emeritus), Teaching Learning Center (TLC), NIT, Warangal	
3 1:45 to 4:00 PM	Best practices / Case studies in Teaching and Learning
4:00 to 4:15 PM	Tea Break
4 4:15 to 4:45 PM	Valedictory Function

Keynote Address

Higher education is a dynamic, continually evolving concept that keeps adapting to the most up-to-date changes. Likewise, the methodology used in teaching and research is equally momentary in nature and demands up to date approaches as well. With the advent of National Assessment and Accreditation Council (NAAC) in India, one can foresee a radical turnaround in the way quality education that will be made available by higher educational institutions in the next few years. The dependence on the already popular teaching aid technology will soon become an indispensable tool that will offer more flexibility to the students and the teachers.

Contemporary engineering education has moved beyond the traditional focus on imparting subject-specific technical knowledge to the inculcation of broader skills in critical thinking and analysis. Given the current demands of the society, where engineers are increasingly employed in multifarious roles in a multicultural and multinational environment, there is now emphasis on improving the quality of education through outcome based education. Outcome based education (OBE) is student-centered instruction model that focuses on measuring student performance through outcomes. Outcomes include knowledge, skill and attitudes.

The OBE model measures the progress of the graduate in three parameters, which are

- Program Educational Objectives (PEO)
- Program Outcomes (PO)
- Course Outcomes (CO)

Program education objectives (PEO) are broad statements that describe the career and professional accomplishments that the program is preparing the graduate to achieve. PDO's are measured 4-5 years after graduation.

Program outcomes are narrower statements that describe what students are expected to know and be able to do by the time of graduation. They must reflect the 12 Graduate attributes as described by NBA for under graduate engineering programs. Course outcomes are the measurable parameters which evaluates each students performance for each course that the student undertakes in every semester.

Methods of assessment

The various assessment tools for measuring course outcome include Mid-Semester and End Semester Examinations, Tutorials, Assignments, Projects work, Labs, Presentations, Employer/Alumni Feedback etc., these course outcomes are mapped to Graduate attributes and program outcomes based on relevance. This evaluation pattern helps through employer satisfaction survey (Yearly), alumni survey (Yearly), Placement records and higher education records.

The adoption of OBE at engineering institution is considered to be a great step forward for higher education in India but actual success lies in the effective adoption and stringent accreditation process to ensure the quality of education is maintained. Therefore as engineering educators our roles become more diversified. The aim is now to produce global engineers with emphasis on transferable skills. At the same time, we have to be aware that the current generation, Gen Z, is different from previous generations. Therefore, teaching methods and evaluation strategies have to be adapted to the changing needs of the youth. Teaching and research need to go hand-in-hand and have to be inclusive of social and environmental awareness.

The traditional classroom set-up is fast being replaced by methods that encourage greater participation and interaction between the students and the teachers. The pedagogical fraternity needs to be committed to engage students in active, collaborative and technology based learning methodologies to develop formative and summative assessments of student progress and learning.

Educators at all levels need, personally and professionally, to take on the vital task of equipping students and scholars to face every challenge and use every opportunity as they become effective and productive global citizens and leaders of tomorrow. Hence, quality education is becoming the need of the hour. Quality in higher education is the most urgent need as India moves towards becoming an educational hub.

The Main Objectives of Seminar

At the end of the module, the participants will be able to:

- Faculty will be able to define the Course Outcomes / Mapping to Program Outcomes / at the end of the course compute the Course attainment / PO attainment and review measures at the end of the semester.
- OBE and importance of alignment of teaching learning triangle i.e., assessment, objectives and instructional strategies.
- Understand different methods and techniques related to Teaching
- Conceptualize different taxonomies and approaches of teaching
- To enable the faculty to develop and use innovative teaching methodology and instructional methods.
- To make the teaching and learning as an enjoyable and non-monotonous process through active learning methodology.

Expected Learning Outcomes

On completion of the module, the participants will be able to:

- Computation of CO/PO attainments and review measures at the end of the semester.
- Learning objectives of course and question paper setting as per blooms taxonomy.
- Teaching as per the transformations in Engineering Education
- Teaching Learning and Evaluation: Tools and handle larger class rooms and quicker way of students as well as faculty evaluation.

The resource persons related to the theme and sub themes are being invited for presentation and discussion

About the Speakers

Dr. B. Kanmani, obtained her Bachelors in Electronics and Communication Engineering form Nagarujuna University in 1987, M.Tech. degree in Digital communication from Indian Institute of Technology, Kanpur in 1990, and PhD from the Indian Institute of Science Bangalore (IISc) in the year 2006. She has been with BMS College of Engineering, Bangalore, since 1995. Currently Dean-Academics, and Professor, Telecommunication Engineering Department, she teaches under-graduate courses related to Signal Processing and Communication. She has steered the department to effective implementation of Outcomes Based Education. She has delivered several invited talks in the domain of Outcomes Based Education. Her research is the domain of Diffuse Optical Tomography, Signal Processing Education and Engineering Education. Her prior employment as a teaching faculty was with Thadomal Shahani College of Engineering, Mumbai.

Dr. Madhuri Mavinkurve has completed her Ph.D. from IDP in Educational Technology at IIT Bombay in 2015. She is an active alumni member of Educational Technology, IIT Bombay. Her research interest are Engineering design competencies assessment and development. Development of valid and reliable assessment instrument - rubrics. Development of interactive visual learning material to teach various thiking skills. Development of interactive learning material in electronics circuits.Interested in conducting teacher training seminars based on integration of ET in teaching -learning process She is also a faculty member in Thakur College of Engineering, Mumbai

Dr Ranjit Ramadurai obtained is Ph.D from Materials Research Center, Indian Institute of Science, Bangalore, India. Post Doctoral fellowship from Alexander Von Humboldt Fellow Institute of Electronic Materials and Devices, Leibniz University of Hannover (Fabrication and studies of Silicon well Resonant Tunnel diodes). He received MRSI – Medal" Materials Research Society of India (MRSI) – Medal for young Materials Researcher for the year 2016, "DAE-BRNS – Young scientist research award" in the year 2014 and "Alexander Von Humboldt" - Renewed Research stay to senior researchers for a duration of 3 months in the year 2014.He was also awarded "Excellence in Teaching Award" for the year 2013 in Indian Institute of Technology Hyderabad.

Dr. B. V. Appa Rao Research Fellow (Emeritus), Teaching Learning Center (TLC), NIT, Warangal. He obtained Ph.D from BHU. Under his guidance 18 students were awarded Ph. D. He is associated with nine major research projects. His area of research are Electrochemical science and technology, Corrosion Science, Surfaces and interfaces, and Environmental chemistry. He is heading the teaching learning center in NIT Warangal and delivered many lectures on Best Practices and quality education in various engineering colleges. He visited many engineering colleges in south India to create awareness on Quality Improvement in Technical Education through Outcome Based Education.

Session 1

Resource Person: **Dr B Kanmani**

The purpose of the accreditation by NBA is to promote and recognize excellence in technical education in colleges and universities—at the undergraduate and post graduate levels, support and advice to technical Institutions in the maintenance and enhancement of their quality of provision.

Main Purpose of accreditation

- ❖ Confidence and assurance on quality to various stakeholders including students.
- ❖ Assurance of the good standing of an institution to government departments and other interested bodies.
- ❖ Enabling an Institution to state publicly that it has voluntarily accepted independent inspection and has satisfied all the requirements for satisfactory operation and maintenance of quality in education.

The purpose and impact of accreditation goes far beyond quality assurance of an Institution/programme.

Major impacts of accreditation system are summarized below

- Encourages quality improvement initiatives by Institutions,
- Improves student enrollment both in terms of quality and quantity,
- Helps the Institution in securing necessary funds,
- Enhances employability of graduates,
- Facilitates transnational recognition of degrees and mobility of graduates and professionals,
- Motivates faculty to participate actively in academic and related Institutional / departmental activities,
- Helps create sound and challenging academic environment in the Institution, and Contributes to social and economic development of the country by producing high quality technical manpower.

The process of accreditation helps in realizing a number of benefits, such as:

- ✓ Helps the Institution to know its strengths, weaknesses and opportunities.
- ✓ Initiates Institutions into innovative and modern methods of pedagogy
- ✓ Gives Institutions a new sense of direction and identity.
- ✓ Provides society with reliable information on quality of education offered.
- ✓ Promotes intra and inter-Institutional interactions.

Accreditation is market-driven and has an international focus. It assesses the characteristics of an Institution and its programmes against a set of criteria established by National Board of Accreditation.

Accreditation signifies different things to different stakeholders.

Benefits to Institutions

- Accreditation process quantifies the strengths, weaknesses in the processes adopted by the Institution and provides directions and opportunities for future growth.
- NBA accredited Institutions may be preferred by funding agencies for releasing grants for research as well as expansion etc.
- NBA provides a quality seal or label that differentiates the Institutions from its peers at the national level. This leads to a widespread recognition and greater appreciation of the brand name of Institutions and motivates the Institutions to strive for more.

Benefits to Students

Students studying in NBA accredited Institutions can be assured that they will receive education which is a balance between high academic quality and professional relevance and that the needs of the corporate world are well integrated into programmes, activities and processes. It signifies that he has entered the portals of an Institution, which has the essential and desirable features of quality professional education.

Benefits to Employers

- Accreditation assures prospective employers that students come from a programme where the content and quality have been evaluated, satisfying established standards.
- It also signifies that the students passing out have acquired competence based on well established technical inputs.

Benefits to Public

Accredited status represents the commitment of the programme and the Institution to quality and continuous improvement.

Catalyst for International Accreditations:

- Due to accreditation from NBA, the Institution's systems and procedures get aligned with the Institution's Mission and Vision.
- All essential prerequisites for international accreditation are included in the accreditation process of NBA.

- Therefore, NBA acts as a catalyst for the Institutions planning to acquire International Accreditation.

Benefits to Industry and Infrastructure Providers:

- It signifies identification of quality of Institutional capabilities, skills and knowledge.

Benefits to Parents

- It signifies that their ward goes through a teaching-learning environment as per accepted good practices.

Benefits to Alumni:

It reassures alumni that alumni are products of an institute with a higher standing in terms of learning.

Benefits to Country:

- Accreditation helps in gaining confidence of stakeholders and in giving a strong message that as a country, our technical manpower is of international standards and can be very useful in enhancing the global mobility for our technical manpower.

Accreditation is focused on implementation of OBE

- Minimum academic quality
- Accredited/Provisionally Accredited/not Accredited
- Awarded for programs (not for the Institute)
- There is no Competition
- Not a Ranking system

Why OBE?

OBE has been adopted for more than a century when educationalists brought to light the importance of appreciating students' individual variation in the learning process, believing that education is best measured by encouraging individual students' achievement that could occur at different rates for different students . The objective of OBE is to ensure that learners are highly equipped with knowledge, skills and attitudes required to become a successful person after they exit the educational system. OBE is an educational process that focuses on future performance skills of the learners and to apply knowledge for achieving their outcomes after they are taught.

Who benefits through OBE?
What infrastructure required for OBE?
Some misconceptions about OBE

The Washington Accord

- Countries are recognized signatories of the Washington Accord
- Countries are recognized provisional signatories of the Washington Accord

Countries recognized as signatories

- Australia,Canada,China,Chinese Taipei ,Hong Kong China
- India,Ireland,Japan ,Korea,Malaysia,New Zealand,Russia,Singapore
- South Africa,Sri Lanka,Turkey,United States
- United Kingdom,Pakistan,Peru

India is recognized as a signatory of the Washington accord in 2014 represented by National Board of Accreditation.

What does this recognition mean?

- Engineering degree from accredited programs, shall be recognized by all countries recognized as members of the Washington Accord

Global recognition : Global Attributes through practicing Outcomes Based Education (OBE)

Global Attributes : Included through the Program Outcomes defined by National Board of Accreditation

What are the Program Outcomes defined by NBA?

1. Engineering Knowledge :Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialisation to the solution of complex engineering problems.

2. Problem analysis :Identify, formulate, research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

3. Design/development of solutions: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.

4. Conduct investigations of complex problems: Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.

5. Modern Tool Usage :Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations.

6. The Engineer and Society :Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal, and cultural issues and the consequent responsibilities relevant to the professional engineering practice.

7. Environment and Sustainability: Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of need for sustainable development.

8. Ethics :Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.

9. Individual and Team Work :Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.

10. Communication: Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.

11. Project Management and Finance :Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.

12. Life-long learning :Recognise the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change

How do we develop the POs defined by NBA?

Where does OBE get Implemented?

- In the class room
- In the examination hall
- In all college campus
- The four years of the program

Effective implementation of OBE leads to:

- Enhanced on-campus placements
- Enhanced Core-placements
- Enhanced off-campus placement
- Enhanced pay package

- Enhanced higher education
- Enhanced entrepreneurs
- Enhanced publications
- Enhanced awards (National/International competitions)
- Enhanced performance in competitive examinations (GATE/CAT/IES)

Implementation of OBE by faculty leads to improvement in student performance and leads to accreditation of the program

Accreditation Parameters

- Vision-Mission, PEOs
- Program Curriculum – Teaching Learning Process
- Course Outcomes and Program Outcomes
- Students' Performance
- Faculty Information & Contribution
- Facilities and Technical Support
- Continuous Improvement
- First year Academics
- Student Support Systems
- Governance, Institutional Support & Financial Recourses

Distinguish between Vision & Mission

- Vision is the Goal
- Mission the process to reach the goal

Globally recognized in the field of Electronics Engineering Education

The Mission of the department

To achieve the Vision through

- Good design of the Curriculum
- Effective implementation of the curriculum
- Implement quality projects
- Pursue research leading quality publications
- Active association with industry
- Provide emphasis on ethical conduct
- Create awareness on concern for society, environment

Vision is a revolutionary statement that the Institution would like to achieve over a long period of time. Mission statements are essentially the means to achieve the vision. The mission should clearly state the purpose of the program. It should indicate the primary functions or activities of the program. It should support the Institute and the Institute missions.

PEO'S: Broad statements that reflect the career accomplishments of the graduates, 3-5 years after graduation, and reflect the purpose of the program

PSO'S: Program Specific Outcomes are defined by the program, specific to the program, and defined by the program

The Program Outcomes (POs)

Program Outcomes are defined by NBA and are measured at the time of graduation are addressed through the Courses of the Curriculum

Course Outcomes:

Course Outcomes are measured at the end of the course, and help in developing/ addressing the POs/PSOs
Every course may have 4-6 Cos

Outcomes Based Education

Developing the POs and the PSOs of the program through the COs of various courses of the Curriculum
Further development of the POs and PSOs through the co-curricular and extra-curricular activities of the program and campus, and outside campus

The Electronics and Communication engineers after 3-5 years of graduation will
PEO1:
PEO2:
PEO3:

Few Examples:

PEOs-Telecommunication Engineering
(http://bmsce.in/department/telecommunication-engg)

Telecommunication Engineering graduates after 3-5 five years of graduation will:

- compete on a global platform to pursue their professional career in Telecommunication Engineering and allied disciplines
- pursue higher education and/or engage in continuous up gradation of their professional skills
- communicate effectively and will demonstrate professional behaviour while working in diverse teams
- demonstrate concern for society and environment

PEOs- Chemical Engineering
http://chemical.nitk.ac.in/programmes

The Chemical Engineering Undergraduate Programme at NITK is designed such that within five years of graduation, the graduates from the Department of Chemical Engineering will

- Advance professionally in the practice of chemical engineering in chemical, petrochemical, fertilizer, pharmaceutical, polymer, materials, biotechnology, energy and other related industries or allied fields.
- Advance professionally in their chosen career path, wherein they apply the communicative, logical, analytical, computational or problem solving skills developed during their graduate study to their professional practice fulfilling the ethical and social responsibilities.
- *S*uccessfully collaborate and work in multidisciplinary teams to tackle complex multifaceted problems.
- Pursue advanced studies and research in Chemical or other related engineering fields, biotechnology and management
- Assume leadership roles in industry or business in the context of societal needs

PEOs- Civil Engineering
http://www.cee.ntu.edu.sg/Programmes/undergraduate/CEE/Pages/Mission.aspx

The Bachelor of Engineering (Civil Engineering) will enable its graduates to:

- achieve a high level of technical expertise for succeeding in the civil engineering profession;
- acquire analytical, problem solving, and lifelong learning skills necessary for their continued professional development so as to stay relevant in an increasingly multi-disciplinary profession;
- be competent in addressing multi-disciplinary challenges in civil engineering and to provide technically sound, economically feasible, and sustainable solutions;
- be socially responsible citizens and be ready to play leadership roles in their profession, public service, and community; and
- have an entrepreneurial spirit for harnessing new opportunities in developing sustainable infrastructure systems.

PEOs- Electrical Engineering
https://www.veltechuniv.edu.in/electrical-and-electronics-engineering

The Electrical Engineering Graduate will:

- design, analyze electrical / electronic equipment, system using the knowledge of Mathematics and Engineering.
- provide practical solution to real time industrial & research problems and pursue higher studies.
- work effectively as individual, teams in various engineering industries & government enterprises.
- be lifelong learners, and demonstrate ethical code of conduct

PEOs-Mechanical Engineering
http://www.mescoepune.org/dept-mech-peos.php

The Mechanical Engineering graduate will have

- Successful career in Core Mechanical and Interdisciplinary Industries through strong foundation in mathematical, scientific and engineering fundamentals. (Pre-preparation)
- An ability to adopt with rapid technological changes with core Mechanical Engineering domain knowledge. (Core Competence)
- An ability to develop their knowledge and skills across the range of disciplines. (Breadth)
- An ability to work in a team and have soft skills with good communication, ethical values. (Professionalism)
- An ability to strengthen their knowledge and skills through self-learning throughout their professional career as well as to pursue higher education. (Learning Environment).

PEOs-Computer Science Program
(http://www.purdue.edu/catalogs/engineering/plansOfStudy/elecCompEng/objectives.html)

The objective of the B.S.EE and B.S.CmpE degree programs is to prepare graduates who will be successful in their chosen career paths. Specifically, graduates of these programs will be capable of achieving:

Success in their chosen profession as evidenced by:

• Career satisfaction.
• Promotions/raises.
• Professional visibility (e.g., publications, presentations, patents, inventions, awards, etc.).
• Entrepreneurial activities.
• International activities (e.g., participation in international conferences, collaborative research, employment abroad, etc.)
and/or

Success in post-undergraduate studies as measured by:
• Satisfaction with the decision to further their education.
• Advanced degrees earned.
• Professional visibility (e.g., publications, presentations, patents, inventions, awards, etc.).
• International activities (e.g., participation in international conferences, collaborative research, employment abroad, etc.).

Graphical Representation

Program educational objectives: A graphical representation', 2014 International Conference on Interactive Collaborative Learning (ICL), WEEF Dubai, December 3 to 6, 2014, DOI: 10.1109/ICL.2014.7017844

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PEOs: Examples to be avoided

Sample: 1

- To acquire fundamental knowledge in basic and applied engineering sciences to formulate and solve problems related to the core Engineering domain
- To provide graduates with a thorough understanding in mathematics, science and engineering fundamentals to develop analytical skills to solve the real life problems in Electronics and Communication Engineering and also to excel in postgraduate programme .
- To provide an opportunity for the student to comprehend, analyze, design and create novel products and solutions individually, in multidisciplinary team and also to be an effective lead.

Sample: 2

- To impart solid foundation of applied mathematics and sciences along with the fundamentals of electronics and telecommunication engineering for sustained contribution in their professional life.
- To help students stay updated with the emerging technologies and to provide them with an opportunity to actively participate in professional communities to enhance professional as well as team-building skills and nourish ever-developing careers
- To develop theoretical and practical knowledge in Electronics & Communication Engineering courses to design/innovate and create novel products/ solutions to real life problems.
- To inculcate the awareness of lifelong learning and to build the graduates with ethics to be responsible citizen, to develop the nation growth and societal transformation needed for a successful professional career.

PEOs: Attainment

- Alumni Survey conducted on graduates who have completed 3-5 years after graduation
- Employer Survey, to obtain details of the performance of our graduates
- May be conducted every year / once every two years
- Committee to conduct/monitor the process (DAC/DAB/BOS)
- The PEO attainment is towards academic improvements
- PEO attainment not explicitly required in the SAR

PEOs: Attainment, Targets set

PEOs: Attainment, Targets set

	Sub-components	Target set	Attainment
Career	Core domain	60%	
	Allied Engineering domain	20%	
	Management	30%	
	Government organizations	20%	
	Outside India	20%	
	Entrepreneurs	10%	
	Non-engineering domain	Less than 10%	
Continuing Education	PG in Engineering in India	20%	
	PG in Engineering outside India	20%	
	MBA program in India	20%	
	MBA program outside India	20%	
	Diploma/Certification/MOOCs/Training/other	20%	
Research	Publications	10%	
	Patents	10%	
Contribution to Society	Financial contribution/other	80%	

PEOs: Establishment

- Aligned to the Vision-Mission of the department
- In consultation with stake holders
- Evolve through discussions/suggestions at various levels
- PEOs are approved by the highest academic body of the college
- PEOs once established are valid for 5-6 years

PEOs: Revision

- ***PEOs are due for revision after 5-6 years***
- ***In consultation with stake holders***
- ***Evolve through discussions/suggestions at various levels***
- ***PEOs are approved by the highest academic body of the college***

NOTE: PEOs are set by the Program and are not defined by NBA
If OBE success is through the following, then why have TEN criteria for assessment?

Effective implementation of OBE leads to:

- Enhanced on-campus placements
- Enhanced Core-placements
- Enhanced off-campus placement
- Enhanced pay package
- Enhanced higher education
- Enhanced entrepreneurs
- Enhanced publications
- Enhanced awards (National/International competitions)
- Enhanced performance in competitive examinations (GATE/CAT/IES)

(PDF) Significance of the Transition to Outcome Based Education: Explore the Future. Available from: https://www.researchgate.net/publication/317593177_Significance_of_the_Transition_to_Outcome_Based_Education_Explore_the_Future [accessed Dec 26 2018].

Session 1 Outcomes

At the end of this session, the participants will have the ability to:

- *Understand significance of the OBE system*
- *Distinguish between Vision, Mission*
- *Define Vision, Mission*
- *Understand Program Educational Objectives (PEOs)*
- *Understand Program Outcomes (POs)*
- *Understand Course Outcomes (COs)*
- *Define Program Educational Objectives (PEOs)*

Session 2 Curriculum Design
Curriculum design: Tier-I Institution

Curriculum design to ensure:

- All the POs defined by NBA are addressed
- The PSOs defined are addressed
- Program Specific Criteria (PSC) by professional Society
- Core competency of the program
- Model Curriculum by AICTE
- Refer Syllabus of GATE/other competitive exams
- Refer curriculum of premier Institutions (National/International)
- Recommendations of Industry/alumni experts

No Gap identified in Curriculum of Tier –I Institutions, because, gaps if any are included in the curriculum

Curriculum design: Tier-2 Institution

Identify Gaps to ensure:

- *Curriculum addresses the POs defined by NBA*
- *Program Specific Criteria (PSC) by professional Society*
- *Develops the Core competency of the program*
- *Model Curriculum by AICTE*
- *Syllabus of GATE*
- *Syllabus of other competitive exams*
- *Consider the curriculum of premier programs (National/International)*
- *Recommendations of Industry/alumni experts*

Address Gaps through:

- *Expert Lectures/Workshops/Value added programs*
- *Communicate to University with recommendations*

AICTE-Model Syllabus
https://www.aicte-india.org/education/model-syllabus

AICTE-Model Syllabus
https://www.aicte-india.org/education/model-syllabus

C. Structure of Undergraduate Engineering program:

S. No.	Category	Suggested Breakup of Credits(Total 160)
1	Humanities and Social Sciences including Management courses	12*
2	Basic Science courses	25*
3	Engineering Science courses including workshop, drawing, basics of electrical/mechanical/computer etc	24*
4	Professional core courses	48*
5	Professional Elective courses relevant to chosen specialization/branch	18*
6	Open subjects – Electives from other technical and /or emerging subjects	18*
7	Project work, seminar and internship in industry or elsewhere	15*
8	Mandatory Courses [Environmental Sciences, Induction training, Indian Constitution, Essence of Indian Traditional Knowledge]	(non-credit)
	Total	160*

**Minor variation is allowed as per need of the respective disciplines.*

Parameters for Curriculum Design

- UGC Circular dated 20-06-2018
- Program Outcomes for UG programs by NBA
- University guidelines (if applicable)
- GATE syllabus
- AICTE Model Curriculum for UG Programs
- Program Specific Criteria by ABET
- Suggestions by stakeholders of the Program
- Recommendations of Academic Bodies

Program Specific Criteria : Civil Engineering

Sample Key Words:

- Calculus
- Process – CV Engineering Contest
- Probability & Statistics
- Sustainability in design
- Public Policy

- Professional ethics
- Project Management
- Business
- Professional Licensure

Mechanical Engineering

Sample Key Words:

- Multivariate Calculus
- Differential Equations
- Model, Analyze, Design and Realize physical systems, components, processes

Electronics Engineering
Computer Science Engineering
Electrical Engineering
Telecommunication Engineering

2018-2019 Criteria for Accrediting Engineering Programs

PROGRAM CRITERIA FOR
ELECTRICAL, COMPUTER, COMMUNICATIONS, TELECOMMUNICATION(S)
AND SIMILARLY NAMED ENGINEERING PROGRAMS
Lead Society: Institute of Electrical and Electronics Engineers
Cooperating Society for Computer Engineering Programs: CSAB

These program criteria apply to engineering programs that include "electrical," "electronic(s)," "computer," "communication(s)," telecommunication(s), or similar modifiers in their titles.

1 Curriculum

The structure of the curriculum must provide both breadth and depth across the range of engineering topics implied by the title of the program.

The curriculum must include probability and statistics, including applications appropriate to the program name; mathematics through differential and integral calculus; sciences (defined as biological, chemical, or physical science); and engineering topics (including computing science) necessary to analyze and design complex electrical and electronic devices, software, and systems containing hardware and software components.

The curriculum for programs containing the modifier "electrical," "electronic(s)," "communication(s)," or "telecommunication(s)" in the title must include advanced mathematics, such as differential equations, linear algebra, complex variables, and discrete mathematics.

The curriculum for programs containing the modifier "computer" in the title must include discrete mathematics.

The curriculum for programs containing the modifier "communication(s)" or "telecommunication(s)" in the title must include topics in communication theory and systems.

The curriculum for programs containing the modifier "telecommunication(s)" must include design and operation of telecommunication networks for services such as voice, data, image, and video transport.

http://www.abet.org/wp-content/uploads/2015/10/E001-16-17-EAC-Criteria-10-20-15.pdf

https://www.hindustantimes.com/education/exit-test-to-be-mandatory-for-engineering-students-to-determine-employability/story-aMOjY0QTbiteh7xsFkL6TJ.html

https://www.hindustantimes.com/education/3-internships-to-be-mandatory-for-engineering-students-javadekar/story-FbWCWwUF6FUxEjjRVGjfxL.html

AICTE-Model Syllabus

https://www.aicte-india.org/education/model-syllabus

C. Structure of Undergraduate Engineering program:

S. No.	Category	Suggested Breakup of Credits(Total 160)
1	Humanities and Social Sciences including Management courses	12*
2	Basic Science courses	25*
3	Engineering Science courses including workshop, drawing, basics of electrical/mechanical/computer etc	24*
4	Professional core courses	48*
5	Professional Elective courses relevant to chosen specialization/branch	18*
6	Open subjects – Electives from other technical and /or emerging subjects	18*
7	Project work, seminar and internship in industry or elsewhere	15*
8	Mandatory Courses [Environmental Sciences, Induction training, Indian Constitution, Essence of Indian Traditional Knowledge]	(non-credit)
	Total	160*

**Minor variation is allowed as per need of the respective disciplines.*

AICTE Structure for various programs

Curricular Component	CV	ME	CH	EE	EC	CS
Humanities and Social Sciences including Management Courses (HS)	12	3+6(E)	12	12	12	12
Basic Science Courses (BS)	26	30	27	26	25	24
Engineering Science Courses (ES)	29	24	27	20	24	29
Professional Core Courses (PC)	47	53.5	55	53	48	49
Professional Elective Courses (PE)	23	18	12	18	18	18
Open Electives (OE)	11	15	12	18	18	12
Project Work (PJ)	12	9	15	11	15	15
Seminar (SR)						
Internship in industry or elsewhere (NT)						
Non-Credit Mandatory Courses (NC)						
Total Credits	160	158.5	160	158	160	159
Total number of Core Courses	16	15	17	14	15	11

Salient Features of the AICTE Model Curriculum

- Recommended range of credits for various curricular components (BS/ES/PC/PE/OE etc)
- Significant credits for the Core Courses
- Enhance number of Electives to provide a wide choice for students
- Programs include 3 to five Mini-Projects/Projects
- Biology for Engineers is a Core-Course
- Non-credit courses to enhance student values and competency
- Semester Break Internships that may be taken up in an industry/academic organization

GATE- 2018-19

GATE SYLLABI FOR VARIOUS UNDERGRADUATE PROGRAMS

	CV	EC, TE	EE	ME	EI	CH	BT	CS & IS	Industrial Engineering	AE
1	Engineering Mathematics	Engineering Mathematics	Engineering Mathematics	Engineering Mathematics	Engineering Mathematics	Engineering Mathematics	Engineering Mathematics	Engineering Mathematics	Engineering Mathematics	Engineering Mathematics
2	Geomatics Engineering	Control Systems	Control Systems	Materials, Manufacturing and Industrial Engineering	Control Systems	Instrumentation and Process Control	Bioprocess Engineering and Process Biotechnology	Computer Networks	General Engineering	Flight Mechanics
3	Structural Engineering	Networks	Electric Circuits	Fluid Mechanics and Thermal Sciences	Electrical Circuits	Process Calculations and Thermodynamics	General Biotechnology	Digital Logic	Manufacturing Process-I	Space Dynamics
4	Geotechnical Engineering	Electronic Devices	Electromagnetic Fields	Applied Mechanics and Design	Signals and Systems	Fluid Mechanics and Mechanical Operations	Recombinant DNA Technology	Computer Organization and Architecture	Manufacturing Process-II	Aero Dynamics
5	Water Resources Engineering	Analog Circuits	Signals and Systems	-	Communication and Optical Instrumentation	Heat Transfer	Plant and Animal Biotechnology	Programming and Data Structures	Quality and Reliability	Structures
6	Environmental Engineering	Digital Circuits	Electrical Machines	-	Analog Electronics	Mass Transfer	-	Algorithms	Industrial Engineering	Propulsion
7	Transportation Engineering	Signals and Systems	Power Systems	-	Digital Electronics	Chemical Reaction Engineering	-	Theory of Computation	Operations Research and Operations Management	-
8	-	Communications	Power Electronics	-	Measurements	Chemical Technology	-	Compiler Design	Project Management	-
9	-	Electromagnetics	Electrical and Electronic Measurements	-	Sensors and Industrial Instrumentation	Plant Design and Economics	-	Operating System	-	-
10	-	-	Analog and Digital Electronics	-	-	-	-	Databases	-	-

'Engineering Mathematics' Common for all programs
'Control Systems' is common for EC, TE, EE, EI
'Digital Logic/Circuits' is common for CS, IS, EC, TE

'Manufacturing Process' Common for ME, IEM
'Fluid Mechanics' is common for CH, ME
'Instrumentation & Process Control' is common for EI, CH

Typical Distribution of Credits among Curricular Components

Semester	Humanities and Social Sciences, Management Course (HS)	Basic Science Course (BS)	Engineering Science Course (ES)	Professional Core Course (PC)	Professional Elective Course (PE)	Open Elective Course (OE)	Project/ Mini-Project (PW)	Seminar - Technical (SR)	Seminar -Internship (SR)	Non-Credit Mandatory Course (NC)	Total Credits
I		9	11							A1	20
II		9	11							A2	20
III	1	4	4	13			1			A3	23
IV	1	4		15			1		1	A4	22
V	2			15	3		2	1		A5	23
VI	2			11	6		2		1	A6	22
VII	3	2			6	6	4	2		A7	23
VIII	3				3	6	8		2	A8	22
Course Total	12	28	26	54	18	12	18	3	4		175

Basic Science Courses (BS)

BS	Course Title	Semester	Credits	POs Mapped
BS-I	Engineering Mathematics-I	I	4	PO1, PO5
BS-2	Applied Physics	I	5	PO1, PO4
BS-3	Engineering Mathematics-II	II	4	PO1, PO5
BS-4	Engineering Chemistry	II	5	PO1, PO2
BS-5	Engineering Mathematics-III	III	4	
BS-6	Engineering Mathematics-IV	IV	4	
BS-7	Biology for Engineers	VII	2	PO1, PO6
TOTAL			28	

Engineering Science Courses (ES)

ES	Course Title	Semester	Credits	POs Mapped
ES-1	Elements of Electronics Engineering	I	3	PO1, PO2, PO3, PO6
ES-2	Engineering Mechanics	I	4	PO1, PO2
ES-3	C Programming	I	4	PO1, PO2, PO3, PO5, PO10
ES-4	Elements of Electrical Engineering	II	4	PO1, PO2, PO4, PO6, PO8
ES-5	Elements of Engineering Drawing	II	3	PO1, PO5
ES-6	Elements of Mechanical Engineering	II	4	PO1, PO4, PO7
ES-7		III	4	
TOTAL			26	

Humanities Science Courses (HS)

ES	Course Title	Semester	Credits	POs Mapped
HS-1	Constitution of India and Professional Ethics	III	1	PO6, PO8
HS-2	Environmental Studies	IV	1	PO7
HS-3	*Entrepreneurship (for example)*	V	2	PO11
HS-4	*Project Management and Finance (for example)*	VI	2	PO11
HS-5 (Core/Elective)	*Cyber Law and Ethics (for example)*	VII	3	PO8
	Intellectual Property Rights; (for example)			
HS-6 (Core/Elective)	*Engineering Economics (for example)*	VIII	3	PO6, PO11
	Sustainable Practices in Mechanical/ Civil/Electronics Engineering/ (for example)			
TOTAL			12	

Mini-Project/Project Work (PW)

PW	Course Title	Semester	Credits	POs Mapped
PW-1	*Based on application of I/II semester concepts*	III	1	PO2, PO3
PW-2	*Based on application of III/IV semester concepts (complexity of 2-3 experiments)*	IV	1	PO2, PO3
PW-3	*Project based on re-engineering equipment/ device/ software / any other*	V	2	PO3, PO4, PO5
PW-4	*Multidisciplinary Project (affinity groups/ professional body / Project for Campus / Community Project/ any other)*	VI	2	PO3, PO5, PO6, PO9, PO10
PW-5	*Based on partial reproduction of identified research/patent*	VII	4	PO4, PO5, PO10, PO12
PW-6	*Review Based/ Research Based/ Application Based/ Innovative/ Extension of earlier project*	VIII	8	PO1 through PO12
TOTAL			**18**	

Note: II/III year Project to be demonstrated within first two weeks of semester commencement, followed by submission of project report, Oral Presentation, Business Plan during the semester
VII and VIII semester shall have continuous evaluation through out the semester

Humanities Science Courses (HS)

ES	Course Title	Semester	Credits	POs Mapped
HS-1	Constitution of India and Professional Ethics	III	1	PO6, PO8
HS-2	Environmental Studies	IV	1	PO7
HS-3	*Entrepreneurship (for example)*	V	2	PO11
HS-4	*Project Management and Finance (for example)*	VI	2	PO11
HS-5 (Core/Elective)	*Cyber Law and Ethics (for example)*	VII	3	PO8
	Intellectual Property Rights; (for example)			
HS-6 (Core/Elective)	*Engineering Economics (for example)*	VIII	3	PO6, PO11
	Sustainable Practices in Mechanical/ Civil/Electronics Engineering/ (for example)			
TOTAL			**12**	

Mini-Project/Project Work (PW)

PW	Course Title	Semester	Credits	POs Mapped
PW-1	*Based on application of I/II semester concepts*	III	1	PO2, PO3
PW-2	*Based on application of III/IV semester concepts (complexity of 2-3 experiments)*	IV	1	PO2, PO3
PW-3	*Project based on re-engineering equipment/ device/ software / any other*	V	2	PO3, PO4, PO5
PW-4	*Multidisciplinary Project (affinity groups/ professional body / Project for Campus / Community Project/ any other)*	VI	2	PO3, PO5, PO6, PO9, PO10
PW-5	*Based on partial reproduction of identified research/patent*	VII	4	PO4, PO5, PO10, PO12
PW-6	*Review Based/ Research Based/ Application Based/ Innovative/ Extension of earlier project*	VIII	8	PO1 through PO12
TOTAL			**18**	

Note: II/III year Project to be demonstrated within first two weeks of semester commencement, followed by submission of project report, Oral Presentation, Business Plan during the semester
VII and VIII semester shall have continuous evaluation through out the semester

Seminar (SR)

SR	Code	Course Title	Semester	Credits	POs Mapped
SR-1		Seminar Based on Summer/Winter Internship (based on social activity/ community service/ NSS/ Rotaract Club/)	IV	1	PO6, PO10
SR-2		Seminar to address Ethics/ Standards/ Environment/ case studies on mega projects/ etc	V	1	PO7, PO8, PO10
SR-3		Seminar Based on Summer/Winter Internship (based on hands-on skill)	VI	1	PO5, PO10
SR-4		Technical Seminar (Based on review of Research Publication/ Patent)	VII	2	PO4, PO10, PO12
SR-5		Seminar Based on Summer/Winter Internship with a government organization or any other organization or a premier Institute or a Research Lab	VIII	2	PO10, PO12
TOTAL				**7**	

Program Electives (PE) / Group Electives (GE)

PE	Code	Course Title	Semester	Credits	POs Mapped
PE-1			V	3	
PE-2			VI	3	
PE-3			VI	3	
PE-4			VII	3	
PE-5			VII	3	
PE-6			VIII	3	
TOTAL				**18**	

- Every student takes SIX Electives
- These Electives may be exclusive to the program, OR may be common for two or more similar programs, for example: (i) Electrical Science (ES) Cluster Programs, (ii) Computer Science (CS) Cluster Programs, (iii) CH, BT Programs, or any other engineering group
- It is suggested to group Courses in streams, so that a set of THREE similar Electives leads to enhanced knowledge in a specified stream:
  - Selecting THREE Electives from Signal Processing Stream *(for example)*
  - Selecting THREE Electives from Communication Stream *(for example)*
  - Selecting THREE Electives from Programming Stream *(for example)*

Open Electives (OE)

OE	Code	Course Title	Semester	Credits	POs Mapped
OE-1			VII	3	
OE-2			VII	3	
OE-3			VIII	3	
OE-4			VIII	3	
TOTAL				**12**	

- Every department shall offer 2-4 Open electives that can be taken by the students of the department and by students of other departments
- Every student takes FOUR Open Electives
- The student can have the opportunity to specialize through suitable selection of Open elective Courses:
  - Selecting all FOUR Electives from Management Stream
  - Selecting all FOUR Electives from Programming Stream
  - Selecting all FOUR Electives from Science Stream
  - Selecting all FOUR Electives from Engineering Stream
  - Selecting all FOUR Electives from Law/Legal Stream

Non-Credit Courses (NC)

NC	Code	Course Title	Semester	Credits	POs Mapped
NC-1		Regional Language	I, II	-	PO8, PO9, PO10, PO12
NC-2	18HS2NCENG	Business English/ Foreign Language		-	PO8, PO9, PO10, PO12
NC-3		*Any Physical Activity: Yoga for Beginners/ Sports/ (for Example)*	III, IV	-	PO9
NC-4		*Any Cultural Activity: Fine Arts/ Music/ Drama/ Theatre/ (for Example)*		-	PO6, PO9, PO12
NC-5		*Human Values through Indian Literature/ Sanskrit Language/ Foreign Language (for Example)*	V, VI	-	PO6, PO8, PO9, PO12
NC-6		*Personality Development and Communication, Aptitude Skill, to help in placements (for Example)*		-	PO9, PO10
NC-7		*Any MOOCs certification (minimum 4-weeks)*	VII, VIII	-	PO12
NC-8		*Any MOOCs certification (minimum 4-weeks)*		-	PO12
TOTAL				**----**	

Sample content for Non-Credit Course: Human Values

Developing Human Values through awareness various cultures involving suitable presentation/ discussion of the following:

- Literary work of Karnataka
- Literary work of any state of India
- Comparison of Cultures
- Movie review
- TED Talks

Any other

Sample content for Non-Credit Course:

Developing the Personality and Communication skills to address:

- Leadership
- Interpersonal Relations
- Stress Management
- Group Dynamics and Team Building
- Conflict Management
- Time management
- Aptitude skills
- Business Communication/ Communication in organizations
- Motivation

Sample Non-Credit Courses: MOOCs

Every student take up and complete any TWO MOOCs offered by recognized on-line platforms like:

- NPTEL (https://nptel.ac.in/)
- SWAYAM (https://swayam.gov.in/)
- GIAN (http://www.gian.iitkgp.ac.in/)
- edX (https://www.edx.org/)
- UDACITY (https://in.udacity.com/)
- Coursera (https://www.coursera.org/)
- UDEMY (https://www.udemy.com/) or any other

The courses need to completed, and supported with certificates, and can be from any domain: Engineering/ Sciences/ Management/ Humanities/ Any other

The courses can be taken up by the student anytime during the program (after having joined the Institution and before graduation)

Every Student Successfully shall complete TWO Courses through MOOC Certifications

The Program Outcomes (POs) as defined by NBA

1 Apply Knowledge
2 Problem Analysis
3 Design/Development of Solution
4 Conduct Investigations
5 Use Modern Tool
6 Engineer and Society
7 Environment and Sustainability
8 Professional Ethics
9 Individual and Team work
10 Communicate Effectively
11 Project Management and Finance
12 Life-Long Learning

Identical for Both Tier-I and Tier-II Institutions

B Kanmani, BMSCE 74

Program Articulation Matrix (Core-Courses)

Sem	Course Code	Credits	PO												PSO		
			1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
3		5	3												1		
3		6	3	3			3					1		1			
3		6	3	2	1		3					1		1		2	
3		4	3	2	1							1					
3		3	3	2		1						1					
4		6	3	2	1		3					1	1	1			
4		6	3	3		1	2					1		1			3
4		4	2	2	1												
4		5	3	2													
4		3	3	3													
7		6	3	2	1		3					1					
7		3	1	1			3				3	3	3	3			
...	.....																
8		3	3	2													
8		10	3	3	3	3	3				3	3	3	3	1	1	3

Program Articulation Matrix (Core-Courses)

Sem	Course Code	Credits	PO												PSO		
			1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
3		5	3												1		
3		6	3	3			3					1		1			
3		6	3	2	1		3					1		1		2	
3		4	3	2	1							1					
3		3	3	2		1						1					
4		6	3	2	1		3					1	1	1			
4		6	3	3		1	2					1		1			3
4		4	2	2	1												
4		5	3	2													
4		3	3	3													
7		6	3	2	1		3					1					
7		3	1	1			3				3	3	3	3			
...	.....																
8		3	3	2													
8		10	3	3	3	3	3				3	3	3	3	1	1	3

Not Recommended;

Few POs are not addressed

Program Articulation Matrix (Core-Courses)

Sem	Course Code	Credits	PO												PSO		
			1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
3		5	3	3	3	3	3	3	3	3	3	3	3	3	2	2	2
3		6	3	3	3	3	3	3	3	3	3	3	3	3	2	2	2
3		6	3	3	3	3	3	3	3	3	3	3	3	3	2	2	2
3		4	3	3	3	3	3	3	3	3	3	3	3	3	2	2	2
3		3	3	3	3	3	3	3	3	3	3	3	3	3	2	2	2
4		6	3	3	3	3	3	3	3	3	3	3	3	3	2	2	2
4		6	3	3	3	3	3	3	3	3	3	3	3	3	2	2	2
4		4	2	3	3	3	3	3	3	3	3	3	3	3	2	2	2
4		5	3	3	3	3	3	3	3	3	3	3	3	3	2	2	2
4		3	3	3	3	3	3	3	3	3	3	3	3	3	2	2	2
7		6	3	3	3	3	3	3	3	3	3	3	3	3	2	2	2
7		3	1	3	3	3	3	3	3	3	3	3	3	3	2	2	2
…	…..			3	3	3	3	3	3	3	3	3	3	3	2	2	2
8		3	3	3	3	3	3	3	3	3	3	3	3	3	2	2	2
8		10	3	3	3	3	3	3	3	3	3	3	3	3	2	2	2

Program Articulation Matrix (Core-Courses)

Sem	Course Code	Credits	PO												PSO		
			1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
3		5	3	3	3	3	3	3	3	3	3	3	3	3	2	2	2
3		6	3	3	3	3	3	3	3	3	3	3	3	3	2	2	2
3		6	3	3	3	3	3	3	3	3	3	3	3	3	2	2	2
3		4	3	3	3	3	3	3	3	3	3	3	3	3	2	2	2
3		3	3	3	3	3	3	3	3	3	3	3	3	3	2	2	2
4		6	3	3	3	3	3	3	3	3	3	3	3	3	2	2	2
4		6	3	3	3	3	3	3	3	3	3	3	3	3	2	2	2
4		4	2	3	3	3	3	3	3	3	3	3	3	3	2	2	2
4		5	3	3	3	3	3	3	3	3	3	3	3	3	2	2	2
4		3	3	3	3	3	3	3	3	3	3	3	3	3	2	2	2
7		6	3	3	3	3	3	3	3	3	3	3	3	3	2	2	2
7		3	1	3	3	3	3	3	3	3	3	3	3	3	2	2	2
…	…..			3	3	3	3	3	3	3	3	3	3	3	2	2	2
8		3	3	3	3	3	3	3	3	3	3	3	3	3	2	2	2
8		10	3	3	3	3	3	3	3	3	3	3	3	3	2	2	2

Not Recommended;

Difficult to effectively implement

Program Articulation Matrix (Core-Courses)

Sem	Course Code	Credits	PO											PSO		
			1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
3		5	3												1		
3		6	3	3			3	1	1	1		1		1			
3		6	3	2	1		3	1	1			1		1		2	
3		4	3	2	1					1		1					
3		3	3	2		1				1		1					
4		6	3	2	1		3					1	1	1			
4		6	3	3		1	2					1		1			3
4		4	2	2	1												
4		5	3	2				1	1								
4		3	3	3													
7		6	3	2	1		3					1					
7		3	1	1			3				3	3	3	3			
…	…..																
8		3	3	2													
8		10	3	3	3	3	3	3	3	3	3	3	3	3	1	1	3

Successful implementation of OBE

Effective implementation of OBE leads to:

- Enhanced on-campus placements
- Enhanced Core-placements
- Enhanced off-campus placement
- Enhanced pay package
- Enhanced higher education
- Enhanced entrepreneurs
- Enhanced publications
- Enhanced awards (National/International competitions)
- Enhanced performance in competitive examinations (GATE/CAT/IES)

Effective implementation of OBE

Through the Curriculum

Through the Outcomes of various courses of the Curriculum

Further through the Co-curricular and Extra-curricular activities

Session 3

How to develop the 12 POs defined by NBA through the Curriculum (designed by the college OR by the University)

1. Engineering Knowledge :Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialisation to the solution of complex engineering problems.

2. Problem analysis :Identify, formulate, research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

3. Design/development of solutions: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.

4. Conduct investigations of complex problems: Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.

5. Modern Tool Usage :Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations.

6. The Engineer and Society :Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal, and cultural issues and the consequent responsibilities relevant to the professional engineering practice.

7. Environment and Sustainability: Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of need for sustainable development.

8. Ethics :Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.

9. Individual and Team Work :Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.

10. Communication: Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.

11. Project Management and Finance :Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.

12. Life-long learning :Recognise the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change

The Program Outcomes (POs) as defined by NBA are identical for both Tier 1 & Tier 2 Institutions

1 Apply Knowledge
2 Problem Analysis
3 Design/Development of Solution
4 Conduct Investigations
5 Use Modern Tool
6 Engineer and Society
7 Environment and Sustainability
8 Professional Ethics
9 Individual and Team work
10 Communicate Effectively
11 Project Management and Finance
12 Life-Long Learning

Graduate Attributes are now known as **Program Outcomes.** In addition to Program Outcomes we need to have **2-4 PSOs**
Program Specific Outcomes (PSOs)

Telecommunication Engineering

- PSO-1: Design, Implement and Analyze Electronic circuits for a given application
- PSO-2: Design, Implement and Analyze Communication system for given specification
- PSO-3: Implement algorithms for processing multimedia data streams using a given engineering tool

How to develop the Program Outcomes (12-POs) and the Program Specific Outcomes (2 to 4 PSOs) ?
We need to address the following,

- 15 Outcomes (POs + PSOs) to be addressed
- More than one course to address a PO
- If we decide to have 2-3 courses addressing each PO/PSO
- Typical 6 courses /semester
- 6 semesters (excluding the First year)

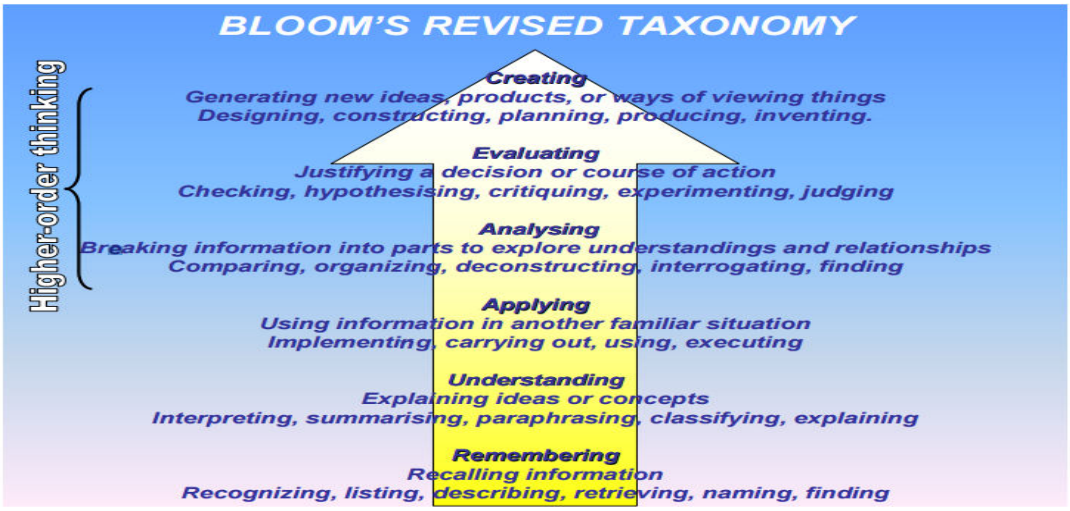
- 36 Courses (excluding Project)

The POs, PSOs need to addressed through the Existing Courses of the Curriculum

Course Outcomes (COs): Characteristics

- Describe skills/competencies gained by student at the end of the course
- need to be assessable and measurable
- Every course has a set of COs
- A course may have about 6 COs
- Every CO addresses one or more outcomes (POs/PSOs)
- Are measured at the end of the course
- Are aligned with one or more POs
- Are closely related to the assessments

The Bloom's Levels



Retrieved from: http://www.kurwongbss.qld.edu.au/thinking/Bloom/blooms.htm

Mapping the Program outcomes with Blooms level's

Bloom's Levels	Program Outcomes
Remember	
Understand	
Apply	**Apply Knowledge**
Analyze	**Problem Analysis**
Evaluate	**Design/Development of Solutions**
Create	**Conduct Investigations**

When we address the Program Outcomes (POs)

- We also address the Bloom's Taxonomy Levels
- The REMEMBER and UNDERSTAND Bloom's Levels are NOT addressed DIRECTLY by the GAs
- NBA does not emphasize the development of this attribute

Defining Course Outcomes
Developing the Remember Attribute

Course Outcome Example 1

At the end of the course the student will have the ability to understand and explain the importance of Fourier Transform

Assessment A1

State and explain Fourier Transform
State and explain the applications of Fourier Transform
Write Short Notes on Fourier Transforms

Course Outcome: Example -A2
At the end of the course the student will have the ability to understand and explain the working of Operational Amplifiers

Assessment A2

Explain with a Block Diagram the working of an Operational Amplifier
List the applications of Operational Amplifiers
Write Short Notes on Operational Amplifiers

The Program Outcomes
PO-1 Apply Knowledge

Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialisation to the solution of complex engineering problems.

Course Outcome: Example -B1

At the end of the course the student will have the ability to obtain the Fourier Transform of a given signal

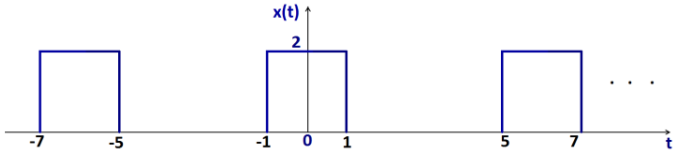
Course Outcome: Example -B1
Assessment -1

At the end of the course the student will have the ability to obtain the Fourier Transform of a given signal

$$x(t) = e^{-4t}u(t)$$

Assessment 2

Obtain the of Fourier Transform of the signal given below



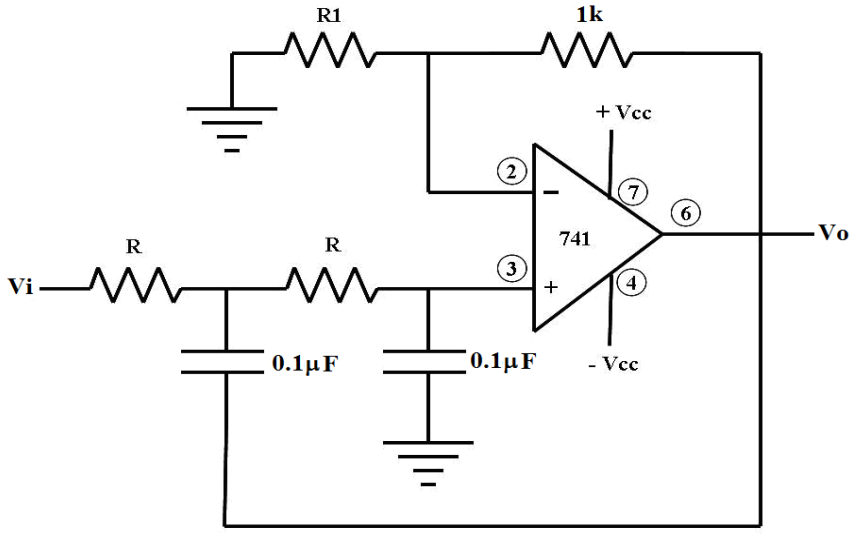
Example B2

At the end of the course the student will have the ability to apply knowledge of mathematics, physics and electronics to obtain the transfer function of the given Analog Electronic Circuit

Assessment 1

Obtain the of Transfer Function of the First Order Active LPF realized using the Operational Amplifier

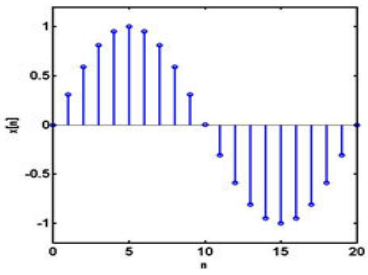
Obtain the of Transfer Function of the circuit given below

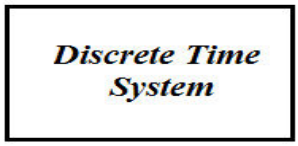


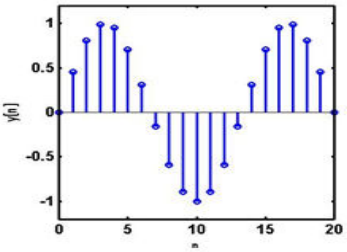
Program Outcome 2 : **Problem Analysis**

Identify, formulate, research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences

Analyze the following systems for linearity

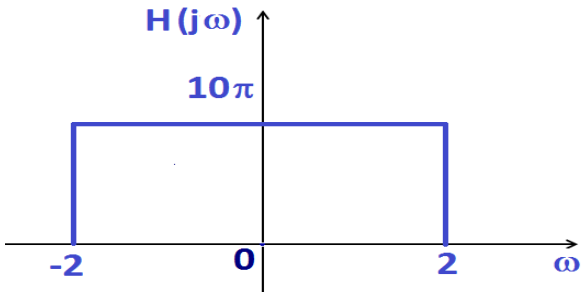






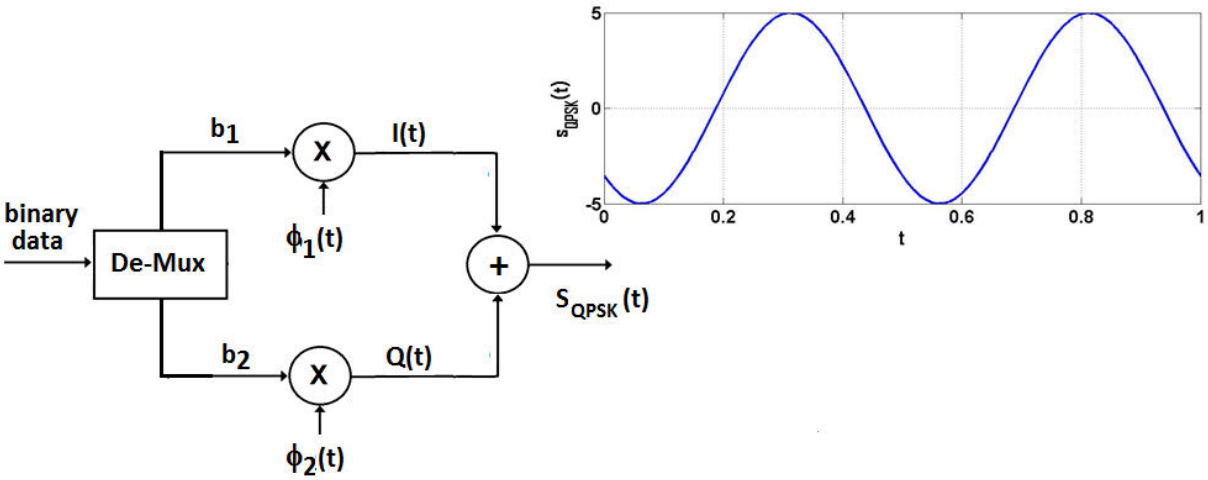
Assessment 2

Analyze the system given below for Stability and Realizability



At the end of the course the student will be able to analyze the digital communication system and arrive at suitable conclusions

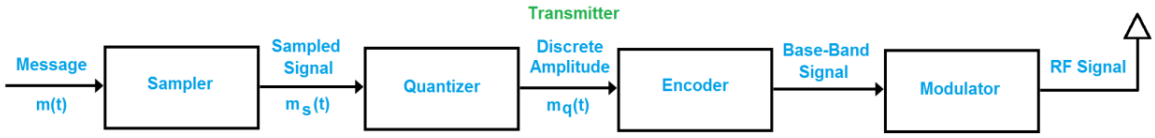
Assessment 1

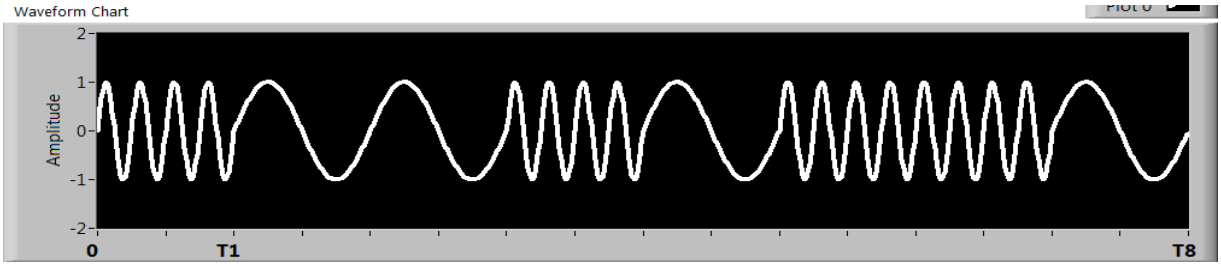


Analyze the Block Diagram given below to obtain the modulation scheme and hence the

Assessment 2

Analyze the information given below to obtain the modulation scheme, the binary sequence and the input sample value (Assume EO standard)





PO-3: Design/Development of Solutions

Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations

Course Outcome: Example -D1

At the end of the course the student will be able to Design the filters to meet given specifications

Assessment 1

Design and give the OP-AMP realization of the analog filter to have 3 dB cut-off at 1 KHz, and at least 12 dB attenuation at 10 KHz.

Design and give the OP-AMP realization of the analog filter to have 3 dB cut-off at 1 KHz, and at least 12 dB attenuation at 10 KHz.

Butterworth Filter
Chebyshev Filter

Assessment 2

Design and arrive at the practical realization of the Digital filter to have 3 dB cut-off at 1 KHz, and at least 12 dB attenuation at 10 KHz, when the sampling frequency is 40KHz.

Design and arrive at the practical realization of the Digital filter to have 3 dB cut-off at 1 KHz, and at least 12 dB attenuation at 10 KHz, when the sampling frequency is 40KHz.

FIR Filter
IIR Filter

PO4 :Conduct Investigations

Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions

Course	Course Outcome
Analog Electronics	**Ability to conduct experiments to validate few parameters from the data sheet of the identified analog electronic component**
Analog Communication	**Ability to implement the end-to-end analog communication system, on the Matlab/LabVIEW platform, and arrive at desired performance charateristics**

B Kanmani, BMSCE 54

PO 5 :Use Modern Tool

Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations

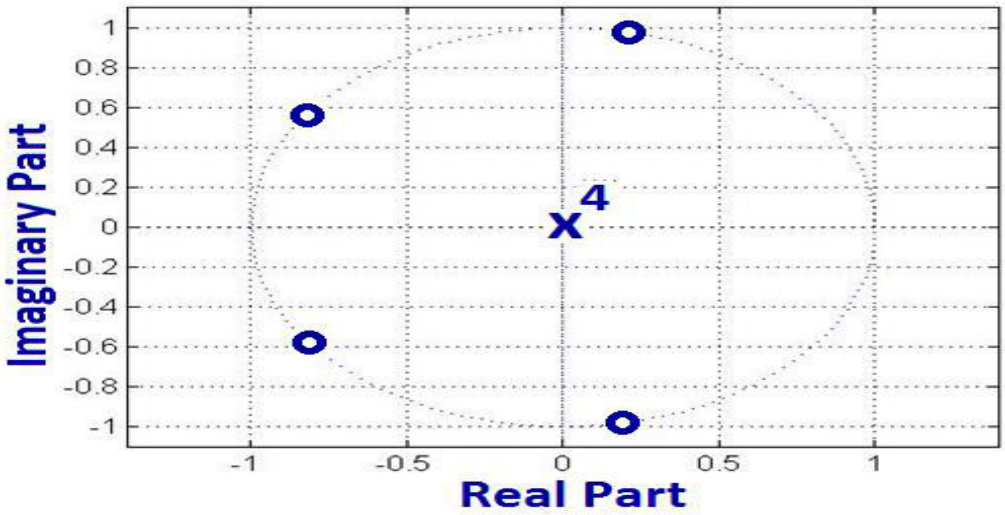
At the end of the course the student will be able to use the modern tool MATLAB develop the code to design and analyze LTI digital systems
Assessment 1

Develop the Matlab Code for performing convolution of two given sequence
Assessment 2

Give the output for each following Matlab commands

```
>> xn = [ 1, 2, 3, 4]
>> sum(xn)
>> sum(xn.*xn)
>> plot(xn)
>> stem(xn)
>> [a, b]  = max(xn)
>>  impz(xn,[1]);
```

The Matlab command: ***zplane ([hn], [1]);*** **resulted in the following output**



i) Obtain the system transfer function H(z)
ii) Obtain hn, the impulse response
iii) Classify the filter as FIR/IIR from the pole-zero plot

Course Outcome Example 2

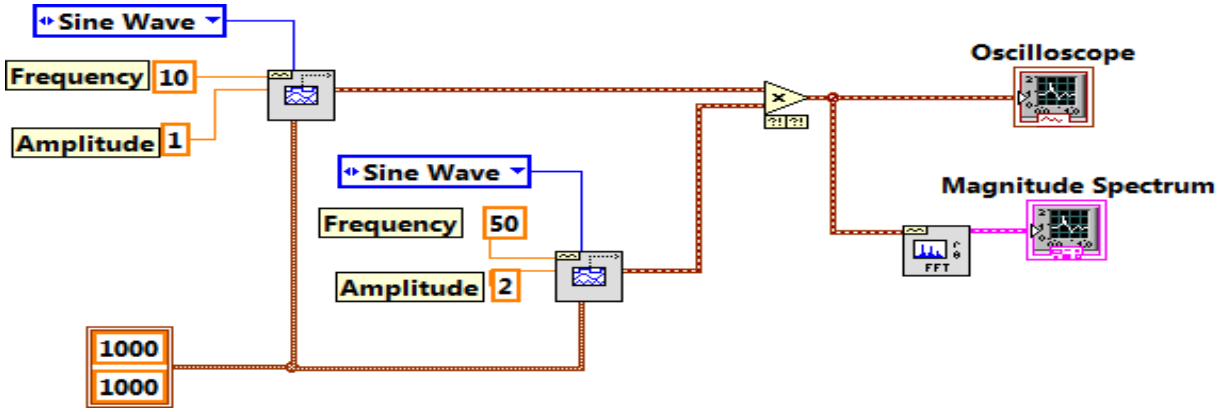
At the end of the course the student will be able to use the modern tool LabVIEW to develop the code for sub-systems in digital communication

Course Outcome: Example -E1

Assessment -1

Given below is the Block Diagram of LabVIEW Code. Sketch the corresponding result on the 'Oscilloscope' and the 'Magnitude Spectrum'. (Free hand sketch)

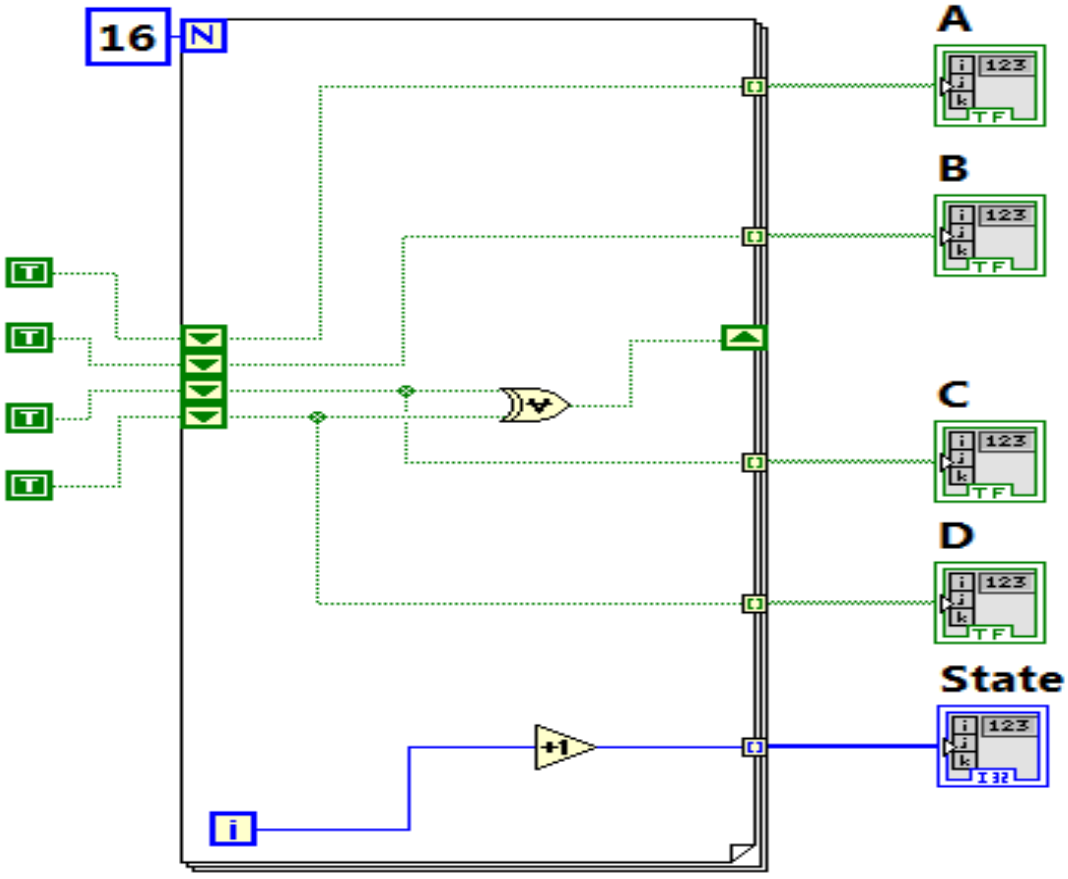
Given below is the Block Diagram of LabVIEW Code. Sketch the corresponding result on the 'Oscilloscope' and the 'Magnitude Spectrum'. (Free hand sketch)



Course Outcome: Example –E2

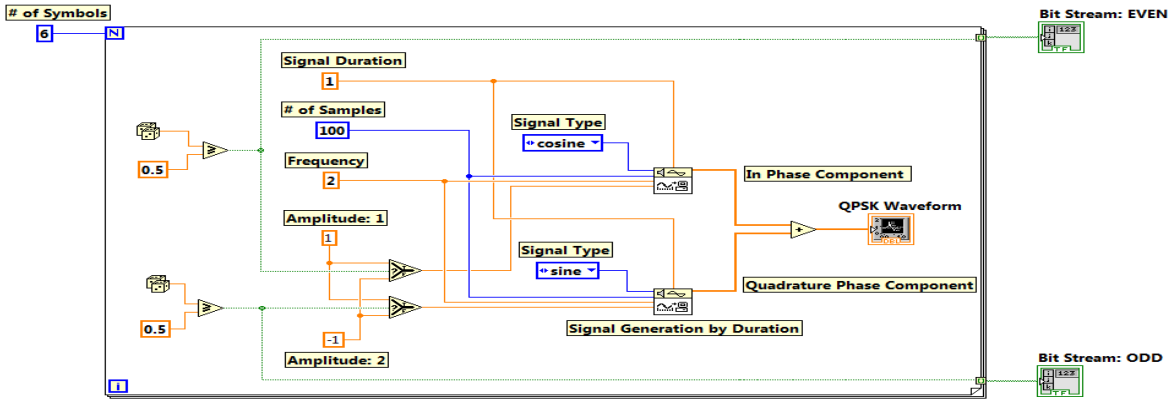
Assessment -2

List the different states of the given LabVIEW code, and check if it generates the PRBS sequence



Course Outcome: Example –E2
Assessment -3

Name the modulation scheme being implemented by the LabVIEW Code



Course Outcome: Example –E3

At the end of the course the student will be able to use the modern tool: C programming to develop the code for engineering applications

Write a Program (WAP) in C to obtain the largest element in an array

Give the output of the C code given below

```
#include <stdio.h>
main()
{
    printf(" I am participating ");
    printf(" in the OBE workshop ");
}
```

It is desired to COUNT the number of LINES in the input running text, fill in the missing code

```
#include <stdio.h>
main()
{
      int c, nl;
      nl=_____;
      while ((c=getchar())!= EOF)
       if (c== _____)
          ++nl;
       printf("%d\n", nl);
}
```

Use of Modern Tool to Remember, Understand, Apply, Analyse, Design, Group Activity (Tool Box)

PO-6 Engineer and Society

Course	Course Outcome
Computer Communication Networks	Ability to demonstrate compliance to the prescribed safety norms through implementation of the identified engineering problem
Project for Community	Ability to identify the community, and implement a suitable project for the benefit of the identified community

PO7 Environment and Sustainability

Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of need for sustainable development.

Course	Course Outcome
Analog Electronic Circuits	Ability to have an awareness of the hazards of electronic waste http://www.deity.gov.in/ http://www.cseindia.org/content/how-dispose-e-waste
Microwave and Radar	Ability to have an awareness of the established norms for transmission power levels through antennas http://emfindia.com/HumanExposureStandards.aspx http://www.who.int/peh-emf/standards/en/

Sustainability: ECE

- Standards/Professional Organizations
- Software Tools
- Aware of the standards/Norms
- Develop Innovative solutions, ensure backward compatibility

Course on Sustainable Electronic Solutions

Course on Sustainable Telecommunication Engineering

Assessments

- Seminar
- QUIZ
- Enact a play
- Submit a report
- Present case-study

PO8 : Professional Ethics

Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice

We can identify TWO distinct components associated with this attribute:

(i) General professional behaviour (common to students from all programs)

(ii) specific professional norms related to the program

Ethics of ECE Department

- Hazards of E-waste management
- Electro magnetic Radiation hazards
- Bandwidth utilization
- Bandwidth transmission
- E-waste management
- Cyber Security

Assessment: Through Seminar/Quiz

E-mail norms GOI

PO-9: Individual and Team work

Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.

Team work

- Function effectively as an individual
- Function effectively in diverse teams in multidisciplinary settings
- Need to assign Group Activities
- Include peer-evaluation (in addition to evaluation by faculty)

Course	Course Outcome
Project Work/ Mini-Project	**Ability to perform in the team, contribute to the team and mentor/lead the team**
Digital Communication	**Ability to develop the Digital Communication Tool Box through a Group activity**

PO-10: Communication effectively

Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.

Possible methods of Introducing Communication Skills in the Engineering Curriculum

Skill	Course	Course Outcome
Reading Skill	Wireless Communication	Ability to read and comprehend research articles (IEEE publications) related to the course
Listening skill	Computer Communication Networks	Ability to listen and comprehend webinars/video lectures offered through the QEEE/NPTEL initiative http://pilot.edureform.iitm.ac.in/ http://www.nptel.ac.in/
Speaking skill	Op-amps & Linear ICs	Ability to make an Oral presentation /submit a video on assigned topics related to course
Writing skill	Project Work	Ability to engage in effective written communication through the one-page poster presentation of the work
Chat skill	Digital Signal Processing	Ability to engage in social networking activities related to the course (essential to have a suitbale platform, for registered candidates of the course) http://wiksateweb.cloudapp.net/

The website used for students to present a seminar in the III semester course on Analog Electronics

http://deity.gov.in/

Example I: Speaking

The IEEE paper used to develop reading skill in the VII semester course on Wireless Communication

Example II:Reading

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IEEE Wireless Communications • June 2014

RESEARCH AND STANDARDS: LEADING THE EVOLUTION OF TELECOM NETWORK ARCHITECTURES

AN ARCHITECTURE FOR SOFTWARE DEFINED WIRELESS NETWORKING

CARLOS J. BERNARDOS, ANTONIO DE LA OLIVA, PABLO SERRANO, ALBERT BANCHS, LUIS M. CONTRERAS, HAO JIN, AND JUAN CARLOS ZÚÑIGA

ABSTRACT

Software defined networking, characterized by a clear separation of the control and data

deploy new ones to address the challenges posed by the increasing customer demands, as well as by the huge competition among operators. All these changes are triggering the need for modifi-

GREEN MEDIA

SUSTAINABLE COMMUNICATION AND NETWORKING IN TWO-TIER GREEN CELLULAR NETWORKS

ZHONGMING ZHENG, XIAOXIA ZHANG, LIN X. CAI, RAN ZHANG, AND XUEMIN (SHERMAN) SHEN

ABSTRACT

With the advances of green energy technologies, clean and sustainable energy sources have been considered as alternative energy sources for powering cellular networks. However, it is idle [1]. In response to the request of reducing energy consumption, and cut the cost of cellular infrastructure operation and management, it is more critical to reduce the energy consumption of the infrastructure compared to wireless terminals. Recent advances in green energy technologies

IEEE Access
practical innovations ⋮ open solutions

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Millimeter Wave Mobile Communications for 5G Cellular: It Will Work!

THEODORE S. RAPPAPORT[1], SHU SUN[1], RIMMA MAYZUS[1], HANG ZHAO[1], YANIV AZAR[1], KEVIN WANG[1], GEORGE N. WONG[1], JOCELYN K. SCHULZ[1], MATHEW SAMIMI[1], AND FELIX GUTIERREZ[1]

[1]NYU WIRELESS, Polytechnic Institute of New York University, New York, NY 11201, USA

Corresponding author: T. S. Rappaport (tsr@nyu.edu)

This work was supported by Samsung DMC R&D Communications Research Team and Samsung Telecommunications America, LLC.

ABSTRACT The global bandwidth shortage facing wireless carriers has motivated the exploration of the underutilized millimeter wave (mm-wave) frequency spectrum for future broadband cellular communication networks. There is, however, little knowledge about cellular mm-wave propagation in densely populated indoor and outdoor environments. Obtaining this information is vital for the design and operation of future fifth generation cellular networks that use the mm-wave spectrum. In this paper, we present the motivation

The IEEE paper used for Abstract writing in the V semester course on DSP Algorithms and Architecture

Example III: Writing

PROGRAMMABLE DSP PLATFORM FOR DIGITAL STILL CAMERAS

Klaus Illgner[1], Hans-Georg Gruber[2], Pedro Gelabert[2], Jie Liang[1], Youngjun Yoo[1], Wissam Rabadi[2], Raj Talluri[1]

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8330 LBJ Freeway, Dallas, TX 75243
[2] Texas Instruments, Incorporated
12203 SW Freeway, Stafford, TX 77477

ABSTRACT

This paper presents a programmable DSP platform for Digital Still Cameras based on the Texas Instruments TMS320C54x family. One major advantage of this platform is that, after capturing an image from a CCD sensor, processing the raw image, and compressing the image for storage is performed on the Digital Signal Processor (DSP). This provides a short shot-to-shot delay and a high degree of flexibility. The system realized also allows instant viewing and selective storing of captured images. This paper outlines the various processing stages necessary to take the raw CCD data and produce a JPEG compressed bit stream and highlighting the advantages of DSPs for this application. The programmable nature of this platform allows for the exploration of different image processing and compression techniques. The low power nature of the digital signal processor provides long battery life.

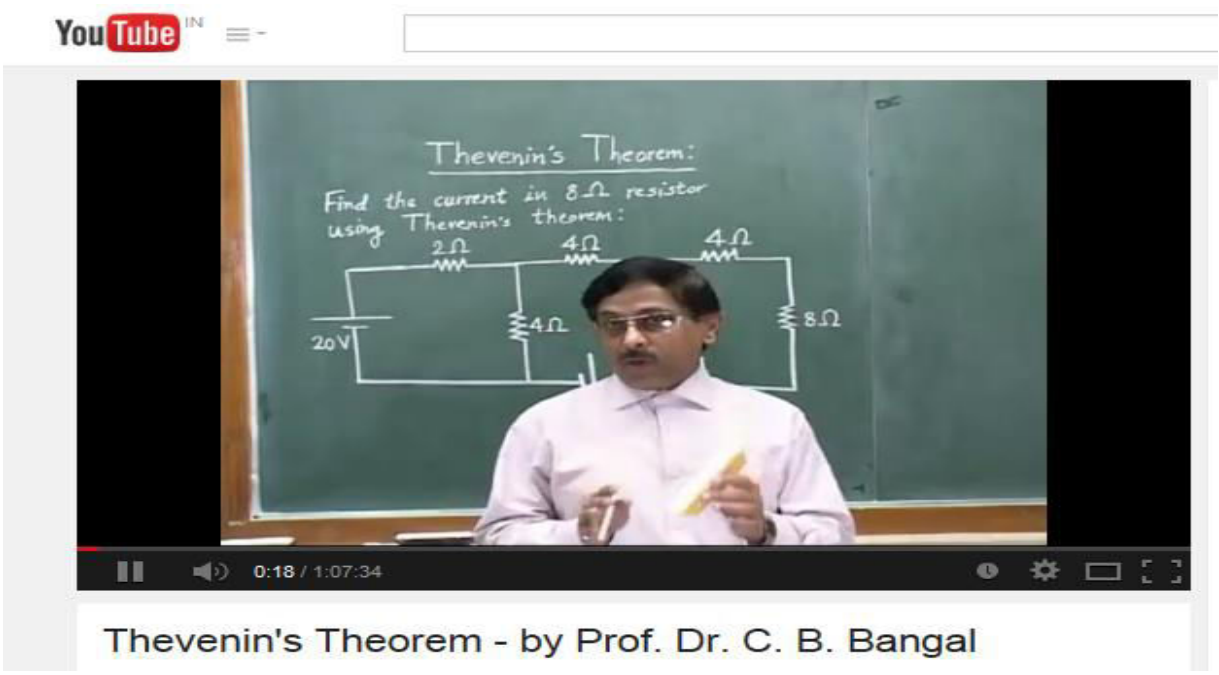
quality image signal from the CCD sensor. This CCD data is then digitized and fed into the DSC Engine. All the image processing and image compression operations are performed in the DSC engine. On most DSCs the user has the ability to view the image to be captured on the LCD display. The captured images are stored on the Flash memory for later use. Most DSC systems also provide an NTSC/PAL video signal to view the captured images (also the preview images) on a TV monitor. The current DSCs also provide a number of ways to connect to the external PC or printer through an RS 232 or a USB port.

Future DSC systems are expected to be even more versatile with the ability to annotate images with text/speech. Including a modem and TCP/IP interface allows for directly connecting to the Internet. Future DSCs will also run more complex multi-tasking operating systems to schedule the various real-time tasks [4].

The NPTEL video clipping on Thevenin's theorem in the

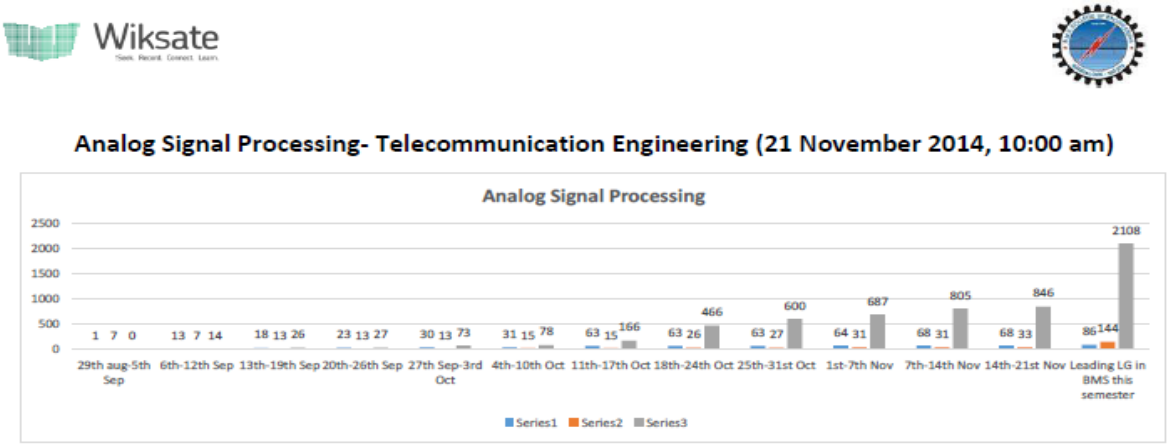
III semester course on Network Analysis

Example IV:Listening



Introducing Intelligence in Social Networking; as part of the Beta Testing; III Semester course on Analog Signal Processing

Example V: CHAT



Project Management

- An introduction to Project Management
- Gantt Chart before start of project
- Actual Chart of Implementation
- Work allocation
- Budget requirements

COST: Resources of the program

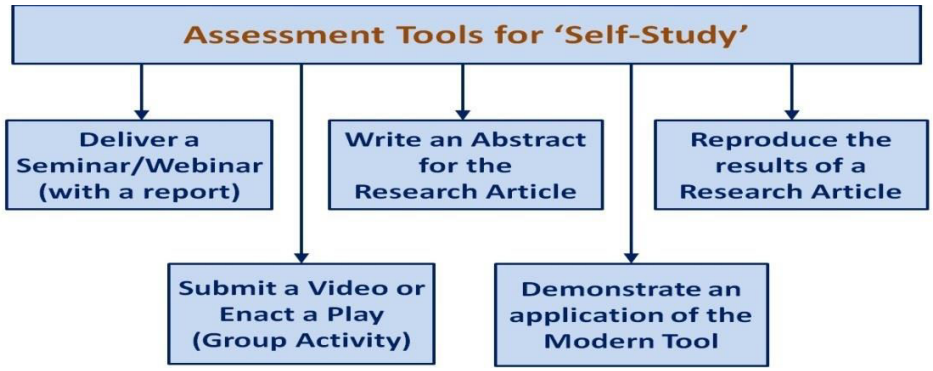
- Area of the IC
- Power consumption
- Bandwidth (scam)
- Implementation speed
- The financial cost
- Weight (Satellite)

PO-12: Life-Long Learning

Recognise the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change

What is 'Life-Long-Learning'?

ability to engage in **independent learning** or **self-study**



Some Examples

Self-Study: Through a Course Outcome (Seminar and Report)

Course Title	The Course Outcome addressing 'self-study'
Analog Electronic Circuits	Ability to engage in independent learning, submit a report and use ICT for effective presentation of the study on assigned topics related to electronic components / E-waste management/ E-waste hazards
Electronic Instrumentation and Measurement	Ability to engage in independent learning, submit a report and use ICT for effective presentation of the study on assigned topics related to electronic instruments
Op-amps & Linear ICs	Ability to engage in independent learning, submit a report and use ICT for effective presentation of the study on assigned topics related to electronic components / E-waste management/ E-waste hazards

Self-Study: Through a Course Outcome (Open-Ended Experiment)

Course Title	The Course Outcome addressing 'self-study'
Discrete Time Signal Processing	Ability to work as an individual to design, formulate, implement and demonstrate discrete time systems/sub-systems through conduction of an Open-Ended experiment using the Matlab engineering programming tool
Multimedia Communication	Ability to function effectively as an individual and as a team member to design, formulate, implement and demonstrate multimedia concepts through implementation of a mini-project
Analog Communication	Ability to work as an individual to design, formulate, implement and demonstrate analog communication systems/sub-systems through conduction of an Open-Ended experiment using the Matlab engineering programming tool /discrete components

Self-Study: other Assessments

Course Title	The assessment tool used to measure 'self-study' component
Microcontrollers	Submission of an abstract for a given Research article
Wireless Communication	Taking up a Quiz on the IEEE Free paper of The month (made available to the students two days earlier)
Network Analysis	Taking up a Quiz after listening to a video made available through NPTEL (National Program on Technology Enhanced Learning [http://www.nptel.ac.in/])
Digital Communication	Taking up a Quiz after listening to a live webinar as part of the National initiative QEEE (Quality Enhancement in Engineering Education [http://pilot.edureform.iitm.ac.in/])

Life-Long Learning': Benefits

It prepares the graduates for their Professional Career

Assessment Tools develop other attributes

- Communication Skills (reading/writing/speaking)
- Awareness of hazards to Environment/Society
- Abide by Professional Ethics
- Awareness of Contemporary Issues
- Awareness of norms by Professional Bodies/ Government Organizations

Life-Long Learning

- Can be introduced in ALL COURSES
- When introduced in most courses
- Becomes a Habit, habit to engage in independent study
- Succeeded in developing the 'Life-Long-Learning' attribute

Defining Outcomes for a Course

Tier-I SAR

CRITERION 3	Course Outcomes and Program Outcomes	175

3.1. Establish the correlation between the courses and the Program Outcomes (POs) & Program Specific Outcomes (25)

- NBA defined Program Outcomes as mentioned in Annexure I and Program Specific Outcomes as defined by the Program. Six to ten matrices of core courses are to be mentioned with at least one per semester.
- Select core courses to demonstrate the mapping/correlation with all POs and PSOs.
- Number of Outcomes for a Course is expected to be around 6.

Program Articulation Matrix

Course	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
C101												
C202												
C303												

Defining Course Outcomes Skill (not the topic)

Example 1: Signals and Systems

Unit I: Signal, System definition
Unit II: Time domain representation
Unit III: Frequency domain representation for non-periodic signals
Unit IV: Frequency domain representation for periodic Signals
Unit V: Analog System design and analysis

At the end of the course, the student will have the		
CO1: Ability to define, understand, and explain continuous time signals and systems	REMEMBER	---
CO2: Ability to obtain the output for LTI systems using the time domain and the frequency domain representation	APPLY	PO1
CO3: Ability to analyze the given specifications of LTI continuous time systems	ANALYZE	PO2
CO4: Ability to design filters for given specifications	DESIGN	PO3

Example 2: Analog Communication

Unit I: Signal Representation
Unit II: Random Process
Unit III: Amplitude Modulation
Unit IV: SSB, VSB form of Modu ation
Unit V: Frequency Modulation

At the end of the course, the student will have the	
CO1: Ability to define, understand and explain concepts of convolution, correlation, random variables, time and frequency domain representation of analog communication systems	Remember
CO2: Ability to apply the knowledge of signal processing to obtain the time and frequency domain representation, Figure of Merit of analog communication systems	Apply
CO3: Ability to analyze the waveforms related to analog communication	Analyze
CO4: Ability to design analog communication systems to meet given specification	Design
CO5: Ability to conduct experiments to demonstrate concepts related to analog communication using suitable electronic components/ Engineering Tool (Matlab)	Modern Tool
CO6: Ability to make an effective oral presentation on broadcast standards, contribution to society, impact on health, effect on environment	Communication; Independent Study
CO7: Ability to perform in a team to build an AM/FM receiver using discrete components and simulation tool (Matlab)	Modern Tool; Design; Analyze;

Example 3: The Engineering Project

COs of the Engineering Project

CO#	Course Outcome	PO#
CO1	Ability to engage in independent study to research literature in the identified domain	PO 12
CO2	Ability to consolidate the literature search to identify and formulate the engineering problem	PO 2

CO3	Ability to identify the community that shall benefit through the solution to the identified engineering problem and also demonstrate concern for environment	PO 6 PO 7
CO4	Ability to demonstrate compliance to the prescribed standards/ safety norms through implementation of the identified engineering problem	PO 8
CO5	Ability to prepare the Gantt Chart for scheduling the project work and designate responsibility of every member in the team	PO 11
CO6	Ability to engage in independent study to identify the mathematical concepts, science concepts, engineering concepts and management principles necessary to solve the identified engineering problem	PO 12
CO7	Ability to engage in independent study to arrive at an exhaustive list of available engineering tools that may be used for solving the identified engineering problem	PO 12 PO 5
CO8	Ability to select the engineering tools/components for solving the identified engineering problem	PO 5
CO9	Ability to apply the identified concepts and engineering tools to arrive at design solution(s) for the identified engineering problem	PO 1 PO 3
C010	Ability to analyse and interpret results of experiments conducted on the designed solution(s) to arrive at valid conclusions	PO 4
C011	Ability to perform the budget analysis of the project through the utilization of resources (finance, power, area, bandwidth, weight, size, any other)	PO 11
C012	Ability to engage in effective written communication through the project report, the one-page poster presentation and the four page IEEE format of the work	PO 10
C013	Ability to engage in effective oral communication through presentation of the project work, demonstration of the project and preparation of the video about the project	PO 10
C014	Ability to perform in the team, contribute to the team and mentor/lead the team	PO 9
C015	Ability to abide by the norms of professional ethics	PO 8

Project Evaluation RUBRICS

Parameter	>70%	40 to 70%	< 40%
Literature Survey	Referred to more than TEN articles; appropriately summarized; includes recent references	Referred to more than SIX articles; appropriately summarized; NO recent references	NO references included
Problem statement	Problem statement is clear, can be implemented and tested, and addresses one of the Engineering Grand Challenge	Problem statement clear, NOT feasible for implementation, and does NOT address the Engineering Grand Challenge	Problem statement NOT clear
Contribution to society, concern for environment	The community that shall benefit clearly specified; ensures safety to environment	Community clearly specified; however safety measures not specified	Hazard to society and to environment
Compliance to Standards	Clear statement of existing Standards/ Norms, with compliance	Clear statement, but does not include compliance	Standards/Norms NOT stated
Project Scheduling and work delegation	Proposed and implemented Gantt chart included; with clear distribution of workload among the team members	Proposed Gantt chart included; without clear distribution of workload	Gantt chart NOT provided; NO distribution of workload
Identification of essential concepts	Clear list, description and justification of MOST essential Mathematical, Science, Engineering and Management Concepts included	SOME essential Mathematical, Science, Engineering and Management Concepts included, without necessary details/ justification	There is NO mention of any of the essential Concepts
Preparing the equipment/ component list	An Exhaustive list of possible Modern Tools/Components that may be used to implement the project is provided, together with a brief comparative study	A list of possible Modern Tools/Components that may be used to implement the project is provided, without the brief comparative study	Only list of modern tool(s) and components being used is provided
The Modern Tool	Clear justification in selecting the TOOL/Components being used is provided	There is no justification for the tool/components being used	--
Design(s)	More than ONE design solution implemented, with comparison	Only ONE design solution implemented	NO design included

Analyze the results	Included clear analysis, along with advantages and disadvantages	Included analysis, without the advantages and disadvantages	NO analysis
Budget Analysis	Budget analysis provided for most of the resources	Budget analysis restricted to finance	NO budget analysis included
The Project Report	well organized, clear objectives and outcomes for every chapter	NOT well organized	NOT submitted by the deadline
The IEEE paper format	All necessary details are included and the paper is well organized	Only few details are included and NOT well organized	The IEEE paper format NOT included
The Poster Presentation	The Poster is well designed and includes the aim, the outcome, the results and conclusion	The Poster is NOT well organized, and includes few details	The Poster is NOT included
Originality score	Plagiarism check (using a software) is less than 60%	Originality score more than 40% and less than 60%	Originality is less than 40%
Oral Presentation	well organized, clear presentation, have equal participation	Slides are not well organized, presentation not clear	Poor organization, No equal role
Video Presentation	well organized, demo included, clear presentation, allocated time well utilized	Not well organized, demo not included, poor utilization of allocated time	Video not submitted
Viva-Voce	Fair knowledge of MOST concepts related to the project	Demonstrates fair knowledge of SOME concepts	NO knowledge of any of the concepts
Performance in the Team	Contributes and cooperates in the team, and mentors/leads the team	cooperates but does NOT contribute to the team	Does NOT cooperate

Project Evaluation Sheet

Parameter	CO Mapped	Maximum Marks	Guide (>50%)	PEC (30%)	External (15%)	Peer (5%)	Total	Remark
Literature Search	CO1	5						
Problem statement	CO2	3						
Society, environment	CO3	2						
Standards/Norms	CO4	3						

Project Scheduling and work delegation	CO5	5						
Identification of essential concepts	CO6	3						
Equipment/ component list	CO7	2						
Effective utilization of the Modern Tool	CO8	3						
Design(s)	CO9	12						
Analyze the results	CO10	5						
Budget Analysis	CO11	2						
The Project Report	CO12	12						
The IEEE paper format	CO12	5						
The Poster Presentation	CO12	3						
Originality score	CO15	10						
Oral Presentation	CO13	10						
Video Presentation	CO13	5						
Viva-Voce (Technical Knowledge)	CO6	5						

Course Outcomes: Observations

- COs written for the skill to be addressed
- COs are NOT written for the topic
- COs are NOT abridged version of the course content
- Not advisable to have TWO COs map to the same PO/PSO
- However, ONE CO can map to more than one PO/PSO
- COs are closely linked to the type of questions/ assignments/ Activities used for assessment
- A Course may have 4-6 COs and hence may map to 4 or more POs
- Not advisable to have ONE course map to ALL POs

Course Outcomes: Topic-wise

At the end of the course, the student will have the
CO1: Ability to define, design and analyze continuous time signals
CO2: Ability to define, design and analyze frequency domain representation of continuous time signals
CO3: Ability to define, design and analyze analog filters
CO4: Ability to define, design and analyze continuous time LTI systems
CO5: Ability to define, design and analyze equalizers
CO6: Ability to define, design and analyze Linear systems with feedback

At the end of the course, the student will have the
CO1: Ability to define, design and analyze continuous time signals
CO2: Ability to define, design and analyze frequency domain representation of continuous time signals
CO3: Ability to define, design and analyze analog filters
CO4: Ability to define, design and analyze continuous time LTI systems
CO5: Ability to define, design and analyze equalizers

Introduce Activities that simultaneously address many Attributes

POs addressed: Activities in Courses

- Seminar
- Read Research Articles
- Implement a Research Paper
- Enact a play
- Submit a video
- Implement a project
- Project for a community
- Social networking group
- Group Activity
- Multidisciplinary activity
- Perform Open-Ended Experiment

Student Activities on Campus

- Learning in the Classroom
- Learning by Doing (performing experiments)
- Delivering Seminars
- Implementing Projects

- Submitting Assignments
- Listening to Videos (NPTEL/QEEE/other)
- Taking Examinations
- Engaging in Independent Study
- Engaging in Discussions/Debates
- Professional Body Activities
- Contests: Participation/Organization

Session 4

Computing Attainments

Refer NBA SAR Tier-I (UG)

Course Articulation Matrix

CO	Statement	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
C202.1													
C202.2													
C202.n													
C202													

Table B.3.1b

Add and delete rows for Course Outcomes as needed

Note:

1. Enter correlation levels 1, 2 or 3 as defined below:

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

Course Articulation Matrix: Example –I

CO	Statement	PO												PSO*		
		1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	Ability to understand and explain continuous time signals and systems concepts	--														
CO2	Ability to apply knowledge of engineering concepts to obtain the desired parameter of given LTI systems	3												1		
CO3	Ability to analyze the given specifications of LTI systems to arrive at valid conclusions		3											3		
CO4	Ability to design filters to meet given specifications			1												
SAS: Signals and Systems		3	3	1	-	-	-	-	-	-	-	-	-	3	-	-

Course Articulation Matrix: Example –II

CO	Statement	PO												PSO*		
		1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	Ability to understand and explain concepts of Field Theory	- -														
CO2	Ability to apply knowledge of engineering concepts to obtain the desired parameter of Electric/Magnetic fields	3												1		
CO3	Ability to analyze the given data of the Electro-magnetic fields to arrive at valid conclusion		3											3		
CO4	Ability to develop Matlab code to comprehend concepts related to the course					2										
CO5	Ability to engage in independent study, make an oral presentation on ethical policies related electromagnetic transmission								1		1		1			
FTH: Field Theory		3	3	-	-	3	-	-	1	1	1	-	1	3	-	-

Course Articulation Matrix: Example –III

CO	Statement	PO												PSO*		
		1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	Ability to understand and explain concepts of analog communication	- -														
CO2	Ability to apply knowledge of engineering concepts to obtain the desired parameter of given analog communication system/sub-system	3												1		
CO3	Ability to analyze the given data of the analog communication block to arrive at valid conclusion		3											3		
CO4	Ability to conduct experiments to comprehend concepts related to the course					3										
CO5	Ability to engage in independent study and work in a team to implement a mini-project					1				1		1	1			
ACM: Analog Communication		3	3	-	-	3	-	-	-	1	-	1	1	3	-	-

Course Articulation Matrix: Example –IV

CO	Statement	PO												PSO*		
		1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	Ability to understand and explain concepts of computer communication networks	- -														
CO2	Ability to apply knowledge of engineering concepts to obtain the desired parameter of the given computer network	3												1		
CO3	Ability to analyze the given data of the computer network to arrive at valid conclusion		3											3		
CO4	Ability to conduct experiments to comprehend concepts related to the course					3										
CO5	Ability to engage in independent study, make an oral presentation on ethical policies related to the course								1		1		1			
CCN: Computer Communication Networks		3	3	-	-	3	-	-	1	1	1	-	1	3	-	-

Course Articulation Matrix: Example –V

CO	Statement	PO												PSO*		
		1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	Ability to understand and explain concepts of computer communication networks	- -														
CO2	Ability to apply knowledge of engineering concepts to obtain the desired parameter of the given computer network	3												1		
CO3	Ability to analyze the given data of the computer network to arrive at valid conclusion		3											3		
CO4	Ability to conduct experiments to comprehend concepts related to the course					3										
CO5	Ability to engage in independent study, make an oral presentation on contribution to society, impact on health, recommended norms for wireless communication						1	1	1		1		1			
WCM: Wireless Communication		3	3	-	-	3	1	1	1	-	1	-	1	3	-	-

Course Articulation Matrix: Example –VI

CO	Statement	PO												PSO*		
		1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	Ability to engage in independent study to research literature in the identified domain												3			
CO2	Ability to consolidate the literature search to identify and formulate the engineering problem		3													
CO3	Ability to identify the community that shall benefit through the solution to the identified engineering problem and also demonstrate concern for environment						3	3								
CO4	Ability to demonstrate compliance to the prescribed standards/ safety norms through implementation of the identified engineering problem								3							
CO5	Ability to prepare the Gantt Chart for scheduling the project work and designate responsibility of every member in the team											3				
CO6	Ability to engage in independent study to identify the mathematical	3											3			

	concepts, science concepts, engineering concepts and management principles necessary to solve the identified engineering problem															
CO7	Ability to engage in independent study to arrive at an exhaustive list of available engineering tools that may be used for solving the identified engineering problem				3							3				
CO8	Ability to select the engineering tools/components for solving the identified engineering problem					3										
PRJ: Project		3	3	-	-	3	1	1	1	-	1	-	1	3	-	-

Course Articulation Matrix: Example –VI (contd.)

CO	Statement	PO												PSO*		
		1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO9	Ability to apply the identified concepts and engineering tools to arrive at design solution(s) for the identified engineering problem	3		3												
CO10	Ability to analyse and interpret results of experiments conducted on the designed solution(s) to arrive at valid conclusions		3		3											
CO11	Ability to perform the budget analysis of the project				3							3		3		

	through the utilization of resources (finance, power, area, bandwidth, weight, size, any other)															
CO12	Ability to engage in effective written communication through the project report, the one-page poster presentation and the four page IEEE format of the work									3						
CO13	Ability to engage in effective oral communication through presentation of the project work, demonstration of the project and preparation of the video about the project									3						
CO14	Ability to perform in the team, contribute to the team and mentor/lead the team								3							
CO15	Ability to abide by the norms of professional ethics (including plagiarism)							3								
PRJ: Project		3	3	3	3	3	3	3	3	3	3	3	3	3	3	3

Project Evaluation RUBRICS

Parameter	>70%	40 to 70%	< 40%
Literature Survey	Referred to more than TEN articles; appropriately summarized; includes recent references	Referred to more than SIX articles; appropriately summarized; NO recent references	NO references included
Problem statement	Problem statement is clear, can be implemented and tested, and addresses one of the Engineering Grand Challenge	Problem statement clear, NOT feasible for implementation, and does NOT address the Engineering Grand Challenge	Problem statement NOT clear
Contribution to society, concern for environment	The community that shall benefit clearly specified; ensures safety to environment	Community clearly specified; however safety measures not specified	Hazard to society and to environment
Compliance to Standards	Clear statement of existing Standards/ Norms, with compliance	Clear statement, but does not include compliance	Standards/Norms NOT stated
Project Scheduling and work delegation	Proposed and implemented Gantt chart included; with clear distribution of workload among the team members	Proposed Gantt chart included; without clear distribution of workload	Gantt chart NOT provided; NO distribution of workload
Identification of essential concepts	Clear list, description and justification of MOST essential Mathematical, Science, Engineering and Management Concepts included	SOME essential Mathematical, Science, Engineering and Management Concepts included, without necessary details/ justification	There is NO mention of any of the essential Concepts
Preparing the equipment/ component list	An Exhaustive list of possible Modern Tools/Components that may be used to implement the project is provided, together with a brief comparative study	A list of possible Modern Tools/Components that may be used to implement the project is provided, without the brief comparative study	Only list of modern tool(s) and components being used is provided
The Modern Tool	Clear justification in selecting the TOOL/Components being used is provided	There is no justification for the tool/components being used	--
Design(s)	More than ONE design solution implemented, with comparison	Only ONE design solution implemented	NO design included
Analyze the	Included clear analysis, along	Included analysis,	NO analysis

results	with advantages and disadvantages	without the advantages and disadvantages	
Budget Analysis	Budget analysis provided for most of the resources	Budget analysis restricted to finance	NO budget analysis included
The Project Report	well organized, clear objectives and outcomes for every chapter	NOT well organized	NOT submitted by the deadline
The IEEE paper format	All necessary details are included and the paper is well organized	Only few details are included and NOT well organized	The IEEE paper format NOT included
The Poster Presentation	The Poster is well designed and includes the aim, the outcome, the results and conclusion	The Poster is NOT well organized, and includes few details	The Poster is NOT included
Originality score	Plagiarism check (using a software) is less than 60%	Originality score more than 40% and less than 60%	Originality is less than 40%
Oral Presentation	well organized, clear presentation, have equal participation	Slides are not well organized, presentation not clear	Poor organization, No equal role
Video Presentation	well organized, demo included, clear presentation, allocated time well utilized	Not well organized, demo not included, poor utilization of allocated time	Video not submitted
Viva-Voce	Fair knowledge of MOST concepts related to the project	Demonstrates fair knowledge of SOME concepts	NO knowledge of any of the concepts
Performance in the Team	Contributes and cooperates in the team, and mentors/leads the team	cooperates but does NOT contribute to the team	Does NOT cooperate

Project Evaluation Sheet

Parameter	CO Mapped	Maximum Marks	Guide (>50%)	PEC (30%)	External (15%)	Peer (5%)	Total	Remark
Literature Search	CO1	5						
Problem statement	CO2	3						
Society, environment	CO3	2						
Standards/Norms	CO4	3						

Project Scheduling and work delegation	CO5	5						
Identification of essential concepts	CO6	3						
Equipment/ component list	CO7	2						
Effective utilization of the Modern Tool	CO8	3						
Design(s)	CO9	12						
Analyze the results	CO10	5						
Budget Analysis	CO11	2						
The Project Report	CO12	12						
The IEEE paper format	CO12	5						
The Poster Presentation	CO12	3						
Originality score	CO15	10						
Oral Presentation	CO13	10						
Video Presentation	CO13	5						
Viva-Voce (Technical Knowledge)	CO6	5						
Performance in the Team	CO14	5						

Attainment: Percentage

3.2.2. Record the attainment of Course Outcomes of all courses with respect to set attainment levels (65)

Program shall set Course Outcome attainment levels for all courses.

Measuring Course Outcomes attained through Semester End Examinations (SEE)

Target may be stated in terms of percentage of students getting equal or more than the target set by the Program in SEE for each CO.

Measuring CO attainment through Cumulative Internal Examinations (CIE)

Target may be stated in terms of percentage of students getting more than class average marks or set by the program in each of the associated COs in the assessment instruments (midterm tests, assignments, mini projects, reports and presentations etc. as mapped with the COs)

CO Attainment through CIE component

Step-I: Map every question to the relevant CO
Step-2: Compute the attainment of every question
Step-3: Compute the average attainment of every CO (through all contributing questions)
Step 4: Compute the strength of the CO (as a relative weightage of marks assigned)
Step 5: Compute the CO attainment, and hence the contribution to the POs, through the Internals Component

Internal Test –I

Q	Statement	CO	Marks
1a		CO1	4
1b		CO1	4
1c		CO1	4
2a		CO2	8
2b		CO2	8
2c		CO2	6
2d		CO2	8
3a		CO3	4
3b		CO3	4
3c			

Attainment of CO2, through CIE component
Consider:
Test-I: Q1 (10 Marks),
Test-I: Q3 (5 Marks),
Test-II: Q2 (10 Marks)
Test-II: Q5 (5 Marks);

Quiz: Q1 to Q5 (10Marks)
CO2: Total 40 Marks

	Marks Secured by the student	
Student 1	**35**	
Student 2	**40**	
Student 3	**20**	
Student 4	**10**	
Student 5	**15**	
Student 6	**ABSENT**	
Student 7	**30**	
Student 8	**40**	
Student 9	**20**	
Student 10	**15**	

Attainment of CO2, through CIE component

	Marks Secured by the student	Attainment
Student 1	35	YES
Student 2	40	YES
Student 3	20	YES
Student 4	10	
Student 5	15	
Student 6	ABSENT	
Student 7	30	YES
Student 8	40	YES

Student 9	20	YES
Student 10	15	

Attainment= 60%

Attainment of CO2, through CIE component

FORMULA:Percentage of students Secured than 80%

	Marks Secured by the student	Attainment
Student 1	35	YES
Student 2	40	YES
Student 3	20	
Student 4	10	
Student 5	15	
Student 6	ABSENT	
Student 7	30	
Student 8	40	YES
Student 9	20	
Student 10	15	

Attainment= 30%

Attainment of CO2, through CIE component

FORMULA:

Percentage of students More than class average

	Marks Secured by the student	Attainment
Student 1	35	YES
Student 2	40	YES
Student 3	20	
Student 4	10	
Student 5	15	
Student 6	ABSENT	
Student 7	30	YES

Student 8	40	YES
Student 9	20	
Student 10	15	

Attainment= 40%
Observation
We repeat the above procedure for all COs of the Course
We decide on ONE formula (College / Department)
Given student performance,
We can get different attainment
Based on the formula used
CO Attainment through CIE component
Total Marks – 100 Marks
CO1: Remember/Understand - 25%
CO2: Apply/Solve/Obtain - 40%
CO3: Design and Analyze – 5%
CO4: Conduct Experiment - 25%
CO5: Seminar – 5%
CO Attainment: Percentage of students more than 60% *(for example)*

CO	Percentage of Questions	Strength of mapping	Attainment	Overall
CO1	**25%**	**2**	**90%**	**90*0.67**
CO2	**40%**	**3**	**70%**	**70**
CO3	**5%**	**1**	**40%**	**40*0.33**
CO4	**25%**	**2**	**85%**	**85*0.67**
CO5	**5%**	**1**	**90%**	**90/3**

The Strength of the CO-PO Mapping
Percentage of questions asked for assessing the attribute

3 more than 20%
2 10 to 20%
1 less than 10%

Every department may arrive at its model for mapping
Assessments for CO
Computed at the end of every semester

Direct Tools:

Continuous Internal Evaluations (80%)
Semester End Examination (10%)

Indirect Tools:

Course End Survey (10%)

These weights are ONLY for CO-PO attainment, and not for award of Grade/Result

CO- Attainment (as a percentage)

- **CIE (80%)**

performance in internals, quiz and other alternate assessments taken as a percentage of students securing more than the threshold (50% for theory; 80% for lab)

- **SEE (10%)**

percentage of students securing Grades S/A/B/C, with weightage to Course Outcomes, based on analysis of the question paper

- **CES (10%)**

based on the analysis of the course end survey

Component	Program Outcome												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CIE (80%)	59	30	-	-	72	89	89	89	81	90	89	90	-	90	-
CES (10%)	91	93	90	-	89	90	90	90	90	90	90	90	-	90	-
SEE (10%)	55	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Overall attainment	62	33	9	-	66	80	80	80	80	80	80	80	-	80	
Strength of Mapping	3	2	1	-	3	1	1	1	1	1	1	1	-	1	-
Attainment considering Strength of mapping	62	22	3	-	66	27	27	27	27	27	27	27	-	27	-

Example 1: Signals and Systems
Unit I: Signal, System definition
Unit II: Time domain representation
Unit III: Frequency domain representation for non-periodic signals
Unit IV: Frequency domain representation for periodic Signals
Unit V: Analog System design and analysis

At the end of the course, the student will have the	
REMEMBER	
APPLY	
ANALYZE	
DESIGN	
At the end of the course, the student will have the	
CO1: Ability to define, understand, and explain continuous time signals and systems	REMEMBER
CO2: Ability to obtain the output for LTI systems using the time domain and the frequency domain representation	APPLY
CO3: Ability to analyze the given specifications of LTI continuous time systems	ANALYZE
CO4: Ability to design filters for given specifications	DESIGN

CO-PO Mapping: Signals & Systems

SEM	CODE	PO												PSO		
		1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
III	CO1	--														
	CO2	3												1		
	CO3		3											3		
	CO4			1												
		3	3	1	-	-	-	-	-	-	-	-	-	3	-	-

Example 2: Digital Electronics
Unit I: Combinational Circuits
Unit II: Flip Flops
Unit III: Sequential Circuits
Unit IV: Sequential Systems
Unit V: Logic Families

At the end of the course, the student will have the	
CO1: Ability to understand, define and explain the fundamental concepts of Digital circuits	Remember
CO2: Ability to apply the knowledge of digital circuit concepts to optimize a digital circuit for the given parameters	Apply
CO3: Ability to analyze digital circuits and arrive at suitable conclusions	Analyze
CO4: Ability to design a digital circuit for given specifications	Design
CO5: Ability to conduct experiments using digital ICs for a given application/problem statement	Modern Tool
CO6: Ability to engage in self-study to formulate, design, implement, analyze and demonstrate an application of digital electronic circuits through an open ended experiment .	PO3, PO4, PO6, PO9, PO10, PO12
CO7: Ability to engage in self-study to deliver a seminar on topics related to the course accompanied by a seminar report (www.deity.gov.in, Comparative study of components, preparing the specifications of components, verifying the data sheets, applications of digital ICs, the characteristics/specifications of different digital ICs, etc)	PO10, PO12

CO-PO Mapping of Digital Electronics

SEM	CODE	PO												PSO		
		1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
DEC	CO1	--														
	CO2	3												3		
	CO3		3											3		
	CO4			2												
	CO5					3										
	CO6			1	1	1				1			1			
	CO7										1		1			
		3	3	3	1	3	-	-	-	1	1	-	1	3	-	-

Measuring POs

CRITERION 3	Course Outcomes and Program Outcomes	175

3.1. Establish the correlation between the courses and the Program Outcomes (POs) & Program Specific Outcomes (25)

- NBA defined Program Outcomes as mentioned in Annexure I and Program Specific Outcomes as defined by the Program. Six to ten matrices of core courses are to be mentioned with at least one per semester.
- Select core courses to demonstrate the mapping/correlation with all POs and PSOs.
- Number of Outcomes for a Course is expected to be around 6.

Program Articulation Matrix (Core-Courses)

Program Articulation Matrix

Course	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
C101												
C202												
C303												
....												
....												
C4...												

Table B.3.1a

Enter correlation levels 1, 2 or 3 as defined below:

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

Program Articulation Matrix (Core-Courses)

Sem	Course Code	Credits	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
3		5	3														
3		6	3	3			3	1	1	1		1		1			
3		6	3	2	1		3	1	1			1		1			
3		4	3	2	1					1		1					
3		3	3	2		1				1		1					
4		6	3	2	1		3					1	1	1			
4		6	3	3		1	2					1		1			
4		4	2	2	1												
4		5	3	2				1	1								
4		3	3	3													
7		6	3	2	1		3					1					
7		3	1	1			3				3	3	3	3			
8		3	3	2													
8		10	3	3	3	3	3	3	3	3	3	3	3	3			
	Total		39	29	8	5	20	6	6	6	6	13	7	10			

Contribution to PO through CO attainment (Core-Courses)

Sem	Course Code	Credits	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
3		5	65														
3		6	75	60			85	55	55	55		80		80			
3		6	80	70	30		85	55	55			85		80			
3		4	65	50	35					55		80					
3		3	55	40		25				55		80					
4		6	75	55	30		75					80	80	80			

4		6	70	45		25	80					80		80			
4		4	60	55	40												
4		5	85	45				80	80								
4		3	45	45													
7		6	55	50	40		75					75					
7		3	75	55			80				90	85	90	80			
8		3	70	60													
8		10	80	85	85	75	75	80	80	75	65	80	85	90			

PO Attainment (Weights)

Sem	Course Code	Credits	PO												PSO		
			1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
3		5	1														
3		6	1	1			1	0.33	0.33	0.33	0.33	0.33	0.33	0.33			
3		6	1	0.66	0.33		1	0.33	0.33			0.33		0.33			
3		4	1	0.66	0.33					0.33		0.33					
3		3	1	0.66		0.33				0.33		0.33					
4		6	1	0.66	0.33		1					0.33	0.33	0.33			
4		6	1	1		0.33	0.66					0.33		0.33			
4		4	0.66	0.66	0.33												
4		5	1	0.66				0.33	0.33								
4		3	1	1													
7		6	1	0.66	0.33		1					0.33					
7		3	1	1			1				1	1	1	1			
8		3	1	0.66													
8		10	1	1	1	1	1	1	1	1	1	1	1	1			
	Total		13.66	10.3	2.65	1.66	6.66	1.99	1.99	1.99	2.33	4.31	2.66	3.32			

PO Attainment: Considering Weights

Sem	Course Code	Credits	PO												PSO		
			1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
3		5	65														
3		6	75	60	0	0	85	18	18	18	0	26.4	0	26			
3		6	80	46.2	9.9	0	85	18	18	0	0	28.1	0	26			
3		4	65	33	12	0	0	0	0	18	0	26.4	0	0			
3		3	55	26.4	0	8.3	0	0	0	18	0	26.4	0	0			
4		6	75	36.3	9.9	0	75	0	0	0	0	26.4	26	26			
4		6	70	45	0	8.3	52.8	0	0	0	0	26.4	0	26			
4		4	39.6	36.3	13	0	0	0	0	0	0	0	0	0			
4		5	85	29.7	0	0	0	26	26	0	0	0	0	0			
4		3	45	45	0	0	0	0	0	0	0	0	0	0			
7		6	55	33	13	0	75	0	0	0	0	24.8	0	0			
7		3	75	55	0	0	80	0	0	0	90	85	90	80			
8		3	70	39.6	0	0	0	0	0	0	0	0	0	0			
8		10	80	85	85	75	75	80	80	75	65	80	85	90			
	Total		935	571	143	92	528	143	143	129	155	350	201	276			
Total			13.66	10.3	2.65	1.66	6.66	1.99	1.99	1.99	2.33	4.31	2.66	3.32			
PO Attainment			68.4	55.5	54	55	79.2	72	72	65	67	81.2	76	83			

Tools used for PO attainment

- **From Every Course (80%)**

  CIE (0.8)

  SEE (0.1)

  CES (0.1)

- **For the Graduating Batch (10%)**

Exit Survey (0.1)

- **Campus Activities (10%)**

Co-curricular activities and

Extra-Curricular activities (0.1)

PO Attainment (Batch Graduating 2015)

Program Outcomes	Contribution Through Core Courses (CIE, SEE, CES) (80%)	Contribution through Exit Survey (10%)	Contribution through Co-curricular and Extra-Curricular Activities (10%)	Overall PO Attainment
PO1: Apply Knowledge	63	75	75	65
PO2: Analyze Problems	61	63	70	62
PO3: Solve Problems	53	63	70	56
PO4: Data Interpretation	54	59	70	56
PO5: Use Modern tools	65	67	74	66
PO6: Concern for society	66	65	75	67
PO7: Concern for environment	60	64	73	62
PO8: Abide by professional ethics	66	69	78	68
PO9: Individual and team member	61	74	82	64
PO10: Communicate Effectively	66	73	81	68
PO11: Project Management	72	66	75	72
PO12: Independent Learning	64	63	83	66

SESSION 5

Continuous Improvement through the attainments

- CIE (80%)

performance in internals, quiz and other alternate assessments taken as a percentage of students securing more than the threshold (50% for theory; 80% for lab)

- SEE (10%)

percentage of students securing Grades S/A/B/C, with weightage to Course Outcomes, based on analysis of the question paper

- CES (10%)

based on the analysis of the course end survey

Component	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CIE (80%)	59	30	-	-	72	89	89	89	81	90	89	90	-	90	-
CES (10%)	91	93	90	-	89	90	90	90	90	90	90	90	-	90	-
SEE (10%)	55	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Overall attainment	**62**	**33**	**9**	**-**	**66**	**80**	**80**	**80**	**80**	**80**	**80**	**80**	**-**	**80**	
Strength of Mapping	**3**	**2**	**1**	**-**	**3**	**1**	**1**	**1**	**1**	**1**	**1**	**1**	**-**	**1**	**-**
Attainment considering Strength of mapping	**62**	**22**	**3**	**-**	**66**	**27**	**27**	**27**	**27**	**27**	**27**	**27**	**-**	**27**	**-**

Assessments for CO

Computed at the end of every semester

Direct Tools:

Continuous Internal Evaluations (80%)

Semester End Examination (10%)

Indirect Tools:

Course End Survey (10%)

Set Targets for attainment

Compute the attainment

Compare the attainment with the target

CO attainment for TWO years

- CO attainment for CAY
- CO attainment for CAYm1

- Compare with targets set
- Compare the POs/PSOs addressed
- Compare the above attainments
- List the steps for improvement

CO attainment

Course Outcome	PO/PSO	CO Attainment	
		CAYm1	CAY
CO1: Ability to apply and analyze basic electrical engineering knowledge of Kirchoff's Current and Voltage Laws, Ohm's Law to linear networks			
CO2: Ability to apply differential equation knowledge of mathematics to Loop and Node analysis of linear networks, and to the solution of passive linear networks			
CO3: Ability to apply mathematical knowledge of initial and final value theorem, to perform time domain analysis of linear passive networks			
CO4: Ability to select and apply network theorems and test linear passive two port networks to obtain desired parameters of passive linear networks			
CO5: Ability to work as an individual to use the modern engineering simulation tool Multisim', to conduct experiments to (i) verify network theorems (ii) analyze the super node and super mesh networks (iii) obtain RLC of a resonant circuit			

Comments by Faculty (CAY/CAYm1
Observations on CO-PO attainment:

_____

_____

_____

Proposed changes in Delivery methods:

_____

_____

_____

Proposed changes in Assessment Tools:

_____

_____

_____

Faculty who handled the course:_____ Signature with Date:_____

The Attainment of a CO

1. Percentage of students getting more than 80% of maximum
2. Percentage of students getting more than 40% of maximum
3. Percentage of students getting more than class average

Each method will result in different attainment

What is good attainment?

Is it good to meet the target?

Measuring POs

PO attainment of an outgoing Batch (Academic Year)

All Courses taken by students of the graduating Batch

PO	Overall PO Attainment	Expected PO Attainment (Target)	REMARKS
PO1	67 %	70 %	
PO2	61 %	70 %	
PO3	51 %	70 %	
PO4	40 %	70 %	
PO5	63 %	70 %	
PO6	39 %	70 %	
PO7	40 %	70 %	
PO8	51 %	85 %	
PO9	70 %	85 %	
PO10	60 %	85 %	
PO11	32 %	85 %	
PO12	54 %	85 %	
PSO1	62 %	85 %	
PSO2	68 %	85 %	
PSO3	57 %	85 %	

PO Attainment of TWO Batches

	PO											
	1	2	3	4	5	6	7	8	9	10	11	12
PO Attainment: CAY												
PO Attainment: CAYm1												
Comments	↑	↑	↓	↑	↑	↓	↑	↑	↑	↓	↑	↓

1. **Ensuring Continuous Improvement through CO Attainment**

- Enhance Target
- Enhance Attainment

Through

- Improving teaching
- Enhancing laboratory component
- Defining new COs/revising COs

2. **Ensuring Continuous Improvement through PO Attainment**

- Enhance Target
- Enhance Attainment

Through

- Improving teaching
- Enhancing laboratory component
- Defining new COs/revising COs
- Introducing value added programs
- Enhancing co-curricular/extra-curricular activities

3. **Ensuring Continuous Improvement through Faculty Contribution**

Enhance Faculty qualification
Enhance Faculty Publication
Enhance Faculty Consultancy

4. **Ensuring Continuous Improvement through CO-PO Mapping**

- Enhance strength of mapping
- Enhance number of outcomes addressed
- Enhance threshold

5. **Ensuring Continuous Improvement through Student Performance**

- Hence effective implementation of OBE leads to:
- Enhanced on-campus placements
- Enhanced Core-placements
- Enhanced off-campus placement
- Enhanced pay package
- Enhanced higher education

- Enhanced entrepreneurs
- Enhanced publications
- Enhanced awards (National/International competitions)
- Enhanced performance in competitive examinations (GATE/CAT/IES)
  AND, there is NO END to continuous improvement

Let us look for answers: PO/PSO

- Who defines the POs?
- Who defines the PSOs?
- Who sets the targets for attainment?
- Is it good to attain the target?
- How do we ensure Continuous Improvement in Quality?

Dr. Madhuri Mavinkurve
(Educational technology trainer, Mumbai)

Dr. Madhuri Mavinkurve focused on Introducing concept of OBE and importance of alignment of teaching learning triangle i.e. assessment, objectives and instructional strategies. Need of learning objectives and what is learning objectives. Faculty members will be guided through hands on activities to write learning objectives for topic from their domains. Hierarchy of learning objectives (Blooms level) is introduced for LOT and HOT. Faculty members will be guided through hands on activities to write learning objectives at all Blooms level.

1. Educational Technology

1.1 Technology *for* Education

Creation and use of technologies for various aspects of the teaching-learning process. (examples)

Creation and use of technology tools, such as Moodle.

1.2 Technology of Education

Creation and use of T-L strategies, such as Peer-discussion, for facilitating students' learning and engagement.

The focus is more on what to do, how to use the technology effectively, rather than the technology itself.

2. Teaching- learning Scenario: Course description

2.1 Course content

There is a course on Embedded system at fifth semester in Electrical branch. The course content is designed at university level by faculty members and experts from industry. Course comprises of chapters ranging from fundamental concepts to latest industrial trends in Embedded system.

One of the course objectives was To design embedded system using 8051 controller

Teaching- learning Scenario: Teaching plan

	Year 1	Year 2
Classroom teaching	• Teacher explained 8051 interface diagram in detail. • She solved design problems using small interfacing devices with some known specifications and routine hardware such as LCD, keyboard etc.	• Teacher explained 8051 interface diagram in detail. • She taught coding for interface connection. • She conducted group activity in which students write code required for interfacing different peripherals and design system for real time problems.
Assessment	▪ Examination question paper on Embedded Systems asks students to: - design the RFID based attendance system using 8051 microcontroller	▪ Examination question paper on Embedded Systems asks students to : - design a system for interfacing LCD display with 8051 microcontroller.

3. Reflection Spot – Think & Write

Question: (Time – 1 min.)

- Predict what would be the assessment outcome for Year 1 and Year 2.

Write down 1 possible outcome for each

4. Teaching-learning Scenario: Assessment Results

	Year 1	Year 2
Outcomes	Out of 60 students, ▪ 2 students thought logically and attempted the design with clarity. ▪ 10 students attempted but approach was illogical and ▪ 48 did not attempt.	▪ All students passed with good grades. ▪ Students who had mugged up the diagrams got good marks and they felt course is scoring. ▪ Students who had solved real time problems with lot of efforts are demotivated as they felt that exams cannot judge their talents.

5. Teaching-learning Scenario: Problem

Teacher is now confused about the approach to teach this course – to what depth should she teach?

Question: (Time – 2 mins.)

- What is the gap in the teaching-learning process that is confusing the teacher ?

(even though course contents are well defined along with objectives)

Question: (Time – 5 mins.)

- What is the gap in the teaching-learning process that is confusing the teacher ?

(even though course contents are well defined along with objectives)

- Discuss your answer with your neighbor

Converge on the most important gap which need to be addressed to avoid teacher's confusion

Question: (Time – 5 mins.)

- What is the gap in the teaching-learning process that is confusing the teacher ?

(even though course contents are well defined

along with objectives)

- Share the most important gap which need to be addressed to avoid teacher's confusion.

6. Some of the gaps in Teaching-Learning process are

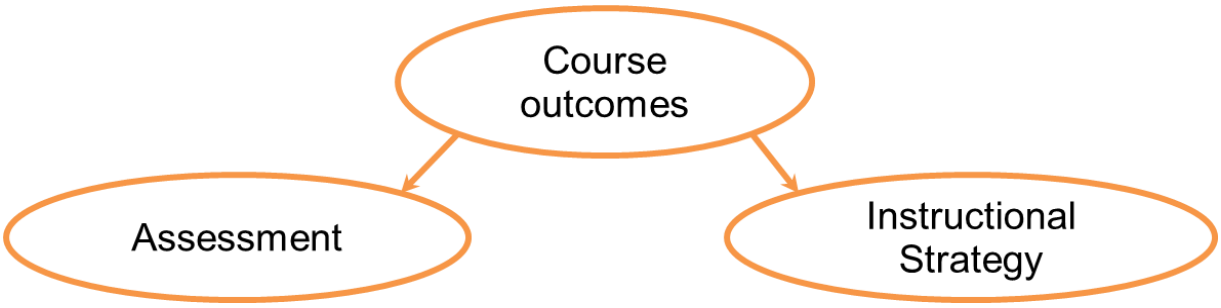
- Diverse understanding of outcomes of the course by different teacher/experts.
- Course Objectives did not provide clear, specific requirement of the course**.**
- Different assessor interpreted course objective in different ways.

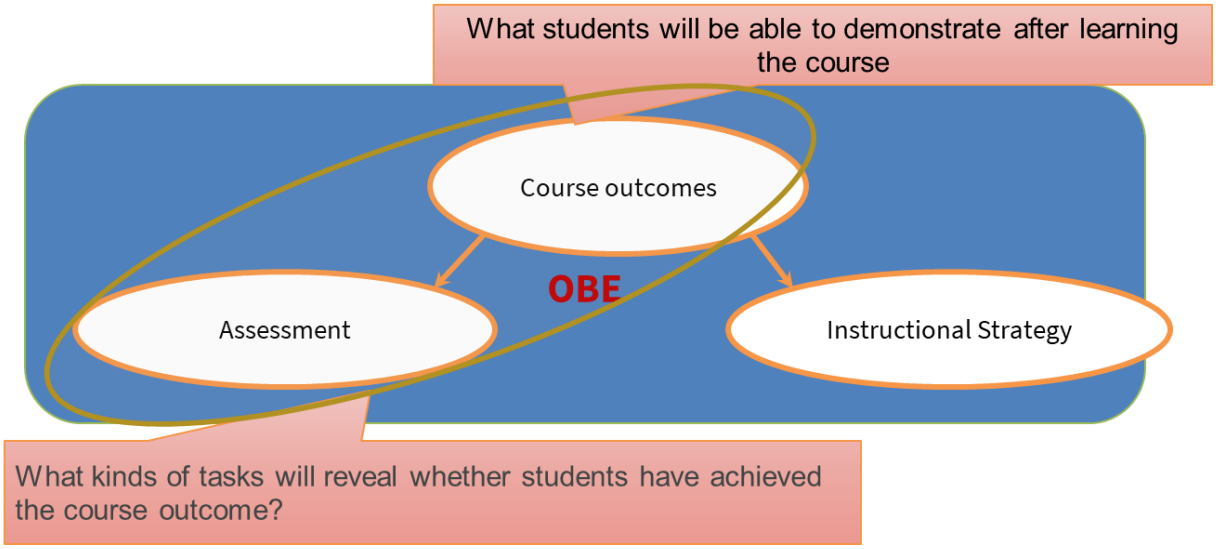
Question: (Time – 2 min.)

Which of the following is most important approach to bring uniformity in teaching the course ?

A. Teachers should cover course by balancing theory and practical component of the course.
B. Teacher need to be alert and find how this course is taught by other teachers from same the university.
C. Syllabus setting committee should define course outcomes clearly so that there will be alignment between the course outcomes, teaching approach and assessment.

7. Alignment of teaching learning process





LEARNING OBJECTIVES :
Why?

WHY DO WE NEED LEARNING OBJECTIVES?

Activity 1: Let's analyze a teaching- learning scenario

Teacher's perspective

- Teacher selected topic of Ohms law.
- She taught the theory behind the law and drew the V-I graph on the board to explain.
- She then solved a number of problems based on Ohms law involving circuits.
- She gave a number of similar numerical problems to students for practice.
- She felt she has covered a variety of Ohms law problems in class.

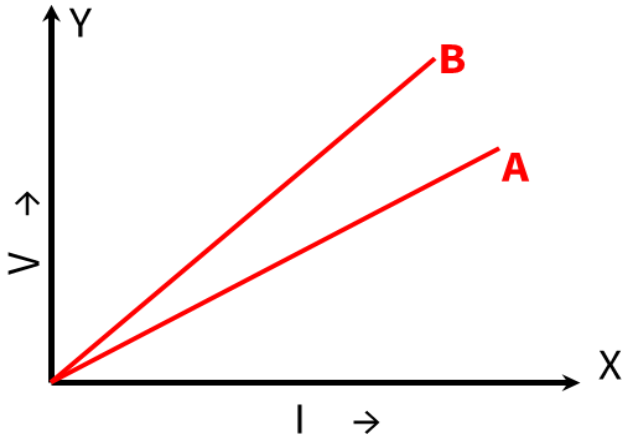
Students' perspective

- Student practiced these problems
  - They were able to calculate current and voltages for given circuit.
  - They were confident of solving numericals based on Ohms law.

Assessment question that came in exam

- There was an assessment test in which one of the questions was based on Ohms law as follows :

The V-I graph for a series combination and for a parallel combination of two resistors is shown in figure. Which of the two, A or B, represents the parallel combination?



Activity 1 : Reflection Spot

Individual Activity:

Qs. Can you predict what would be the student performance in the assessment test?

Think & Write down 1 possible outcome.

Activity 1: Assessment Result

Out of 60 students from the class

2 students were able to solve problem correctly.

10 students attempted problem, but they had interpreted problem wrongly.

Remaining students not attempted the problem.

The overall success of this problem solving exercise was 0.03

Teacher's comment:

The question is simple, they just have to apply logic and solve the problem. I solved variety of circuits in class.

Students' comment:

The question was out of syllabus we have not done such problems in the classroom.

Think (Individually): ***(Time – 3 mins.)***

Qs. Both teacher and students were right, but what went wrong?

Write down 1 possible reason of what went wrong.

Pair (Group activity): ***(Time – 5 mins.)***

Qs. Both teacher and students were right, but what went wrong?

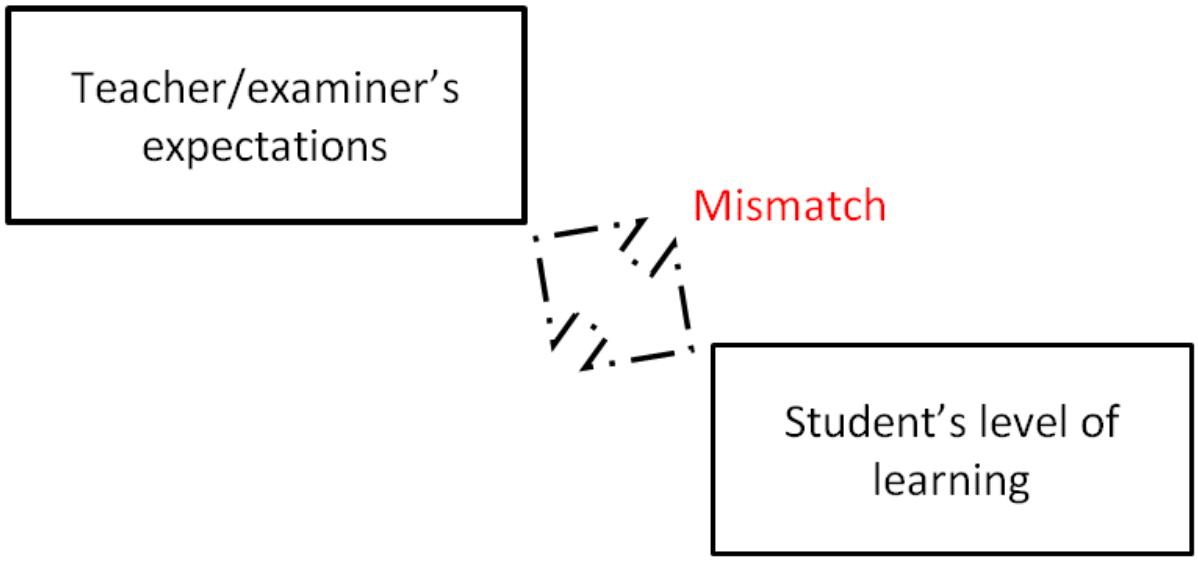
- Discuss your reasons with your neighbor
- Converge on the most important reason for what went wrong.

Share (Group activity): **(Time – 5 mins.)**

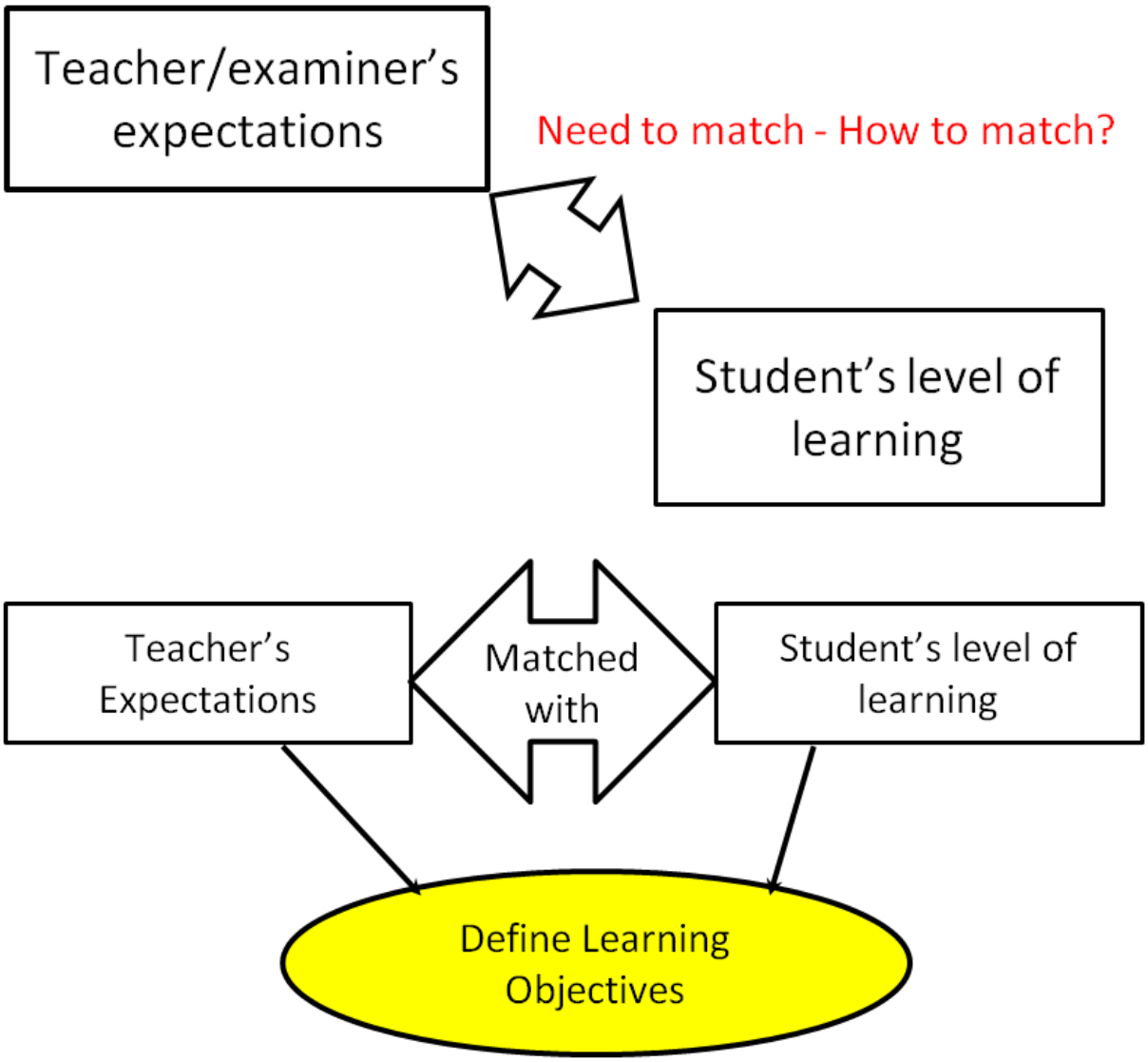
Qs. Both teacher and students were right, but what went wrong?

- Share your group's reason with all of us.

What went wrong in this teaching-learning scenario?



What is the solution?



WHAT ARE LARNING OBJECTIVES?

Learning objectives are goal statements that :

- are **student-centered**
- Specify **measurable performance outcome** of student

Activity 2: Vote

Individual Activity:

Qs. Which of the following is a valid learning objective for topic – Ohms Law?

1. Teacher will teach how Ohms law works
2. Students will be able to understand Ohms law
3. Students will know working of Ohms law
4. All of the above
5. None of the above

Discuss with neighbour and Re-vote:

Qs. Which of the following is a valid learning objective for topic – Ohms Law?

1. Teacher will teach how Ohms law works
2. Students will be able to understand Ohms law
3. Students will know working of Ohms law.
4. All of the above
5. None of the above

- Not student-centered
- Difficult to measure - "understand" "know"

Activity 3 : Vote

Individual Activity:

Qs. Which of the following is a valid learning objective?

1. Students will be able to understand working of Ohms law.
2. Students will be able to know what is Ohms law.
3. Students will be able to explain the application of Ohms law.
4. Teacher will be able to make students solve Ohms law numerical.
5. None of the above.

Discuss with neighbour & Re-vote:

Qs. Which of the following is a valid learning objective?

1. Students will be able to understand working of Ohms law.
2. Students will be able to know what is Ohms law.
3. Students will be able to explain the application of Ohms law.
4. Teacher will be able to make students solve Ohms law numerical.
5. None of the above.

- **Student-centered**
- **Measurable**

HOW TO WRITE VALID LEARNING OBJECTIVES?

DON'T	Need to be
• Understand Ohms law • Visualize working of Ohms law • Know how Ohms law work	Specific and measurable

DON'T	**Instead DO**	**Need to be**
Understand Ohms law Visualize working of Ohms law Know how Ohms law work	Formulate using "action" verbs: identify, list, describe, explain, solve, analyze, design, compare	Specific and measurable

DON'T	**Instead DO**	**Need to be**
• Understand Ohms law • Visualize working of Ohms law • Know how Ohms law work	Formulate using "action" verbs: identify, list, describe, explain, solve, analyze, design, compare	Specific and measurable
• Teach Ohms law • Show simulations to save time.	Student should be able to	Student centered (not what will teacher do)

Activity 4 : Vote Individually

Qs. Which of the following are valid learning objectives?

1. Students will be able to solve numerical problems based on Ohms law.

2. Students will be able to appreciate working of Ohms law.

3. Students will be able to decide best suitable circuit for given applications.

4. Teacher will be able to decide the appropriate circuits for numerical problems.

Qs. Which of the following are valid learning objectives?

1. Students will be able to solve numerical problems based on Ohms law.

2. Students will be able to appreciate working of Ohms law.

3. Students will be able to decide best suitable circuit for given applications.

4. Teacher will be able to decide the appropriate circuits for numerical problems.

- **Student-centered**
- **Measurable**

Activity 5 : Write your own learning objectives

Q. Write 2 learning objectives for your chosen topic

Instructions:

- Make groups of 3 from the same domain
- Each of you choose a topic of your choice from the course you are teaching
- Write 2 learning objectives for your chosen topic
- Now do peer evaluation : Exchange your learning objectives Check if they are valid.

- **Student-centered**
- **Measurable**

Learning Objectives : Action Verbs

Recall	List, Memorize, Relate, Identify, Show, Locate, Reproduce, Quote, Repeat, Label, Group, Read, Write, Outline, Choose, Recite, Match, Cite, Define
Understand	Restate, Discuss, Translate, Give examples of, Paraphrase, Reorganize, Describe, Outline, Account for, Interpret, Explain
Apply	Exhibit, Illustrate, Calculate, Make, Apply, Operate, Change, Compute, Sequence, Solve, Demonstrate, Use, Adapt, Predict
Analyze	Ascertain, Diagnose, Distinguish, Analyze, Examine, Conclude, Infer
Evaluate	Appraise, Conclude, Critique, Decide, Judge, Compare, Contrast, Deduce, Weigh, Evaluate
Create	Combine, Devise, Expand, Plan, Compose, Extend, Create, Design, Invent, Develop, Modify

HIERARCHY OF LEARNING OBJECTIVES

Are learning objectives at the same level?

Important ----Select appropriate action verbs.

Identify the learning objectives of the 2 teachers

Teacher A	Teacher B
1. Teacher selected topic of Ohms law. 2. She taught the theory behind the law and drew the V-I graph on the board to explain. 3. She then asked students to explain what is Ohms law.	1. Teacher selected topic of Ohms law. 2. She taught the theory behind the law and drew the V-I graph on the board to explain. 3. She then solved a number of numerical problems based on Ohms law for a given circuit.

- Student should be able to ------

Teacher A	Teacher B
1. Teacher selected topic of Ohms law. 2. She taught the theory behind the law and drew the V-I graph on the board to explain. 3. She then asked students to explain what is Ohms law	1. Teacher selected topic of Ohms law. 2. She taught the theory behind the law and drew the V-I graph on the board to explain. 3. She then solved a number of numerical problems based on Ohms law for a given circuit.

- Student should be able to explain what is Ohms law
- Student should be able to calculate voltage/current for a given circuit

Are learning objectives at the same level?

No, learning objectives can be at different levels of complexity

Order learning objectives based on their complexity

Q. Arrange the learning objectives given below in descending order of complexity (hierarchy/ level)?

A. Student will be able to define Ohms law

B. Student will be able to calculate current/voltage for given circuit combinations

C. Student will be able to design a circuit for given application

i) A>B>C ii)C>B>A

ii) B>A>C iv) C=B=A

Different expected outcome

1.Student will be able to state Ohms law.

- **Expected outcome- Student will be able to recall statement of Ohms law explained in the class.**

2. Student will be able to calculate current/voltage for given circuit combinations

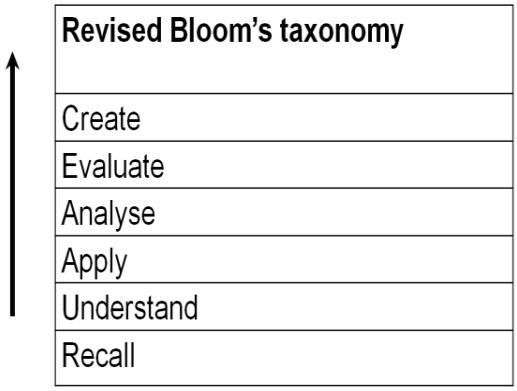
- **Expected outcome- Student will be able to apply Ohms law and calculate values.**

3. Student will be able to design a circuit for given application.

- **Expected outcome----Student will be able to *decide which parameters are required in the application***
  - ***then decide how Ohms law is applicable and***
  - ***then apply to find values.***

How can we assign priority?

- Revised Bloom's taxonomy (RBT)



Hierarchy of cognitive levels

Level	Description –Learning Level	Action Verbs
Create	Generate new ideas, products or ways of looking at things.	design, combine, devise, modify, plan
Evaluate	Judge value based on criteria, decision making	assess, conclude, contrast, evaluate
Analyse	Separate whole into parts until structure of whole and relation between parts is clear	analyze, infer examine, dissect ascertain,
Apply	Use knowledge in a new situation. Involves rules, methods, laws.	Apply, calculate, solve, predict
Understand	Grasp meaning, explain, interpret, translate, paraphrase of memorized info	Describe, Explain, Give example of, Select
Recall	**Focuses on memorization and recall, reproduce**	**List, Identify, Define, State**

Examples of learning objective at Recall Level

- Student will be able to
    - State Ohm's law.
- Expected outcome --- statement of law

Hierarchy of cognitive levels

Level	Description –Learning Level	Action Verbs
Create	Generate new ideas, products or ways of looking at things.	design, combine, devise, modify, plan
Evaluate	Judge value based on criteria, decision making	assess, conclude, contrast, evaluate
Analyse	Separate whole into parts until structure of whole and relation between parts is clear	analyze, infer examine, dissect ascertain,
Apply	Use knowledge in a new situation. Involves rules, methods, laws.	Apply, calculate, solve, predict
Understand	**Grasp meaning, explain, interpret, translate, paraphrase of memorized info**	**Describe, Explain, Give example of, Select**
Recall	Focuses on memorization and recall, reproduce	List, Identify, Define, State

Examples of learning objective at Understand Level

- Student will able to
- Calculate value of current /voltage for given circuit.
- Expected outcome- Interpretation of given circuit and application of law to find values.

Hierarchy of cognitive levels

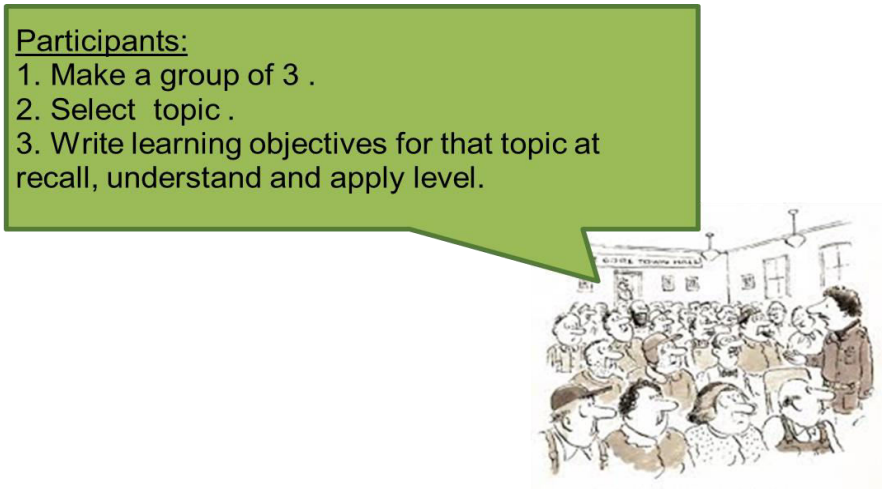
Level	Description –Learning Level	Action Verbs
Create	Generate new ideas, products or ways of looking at things.	design, combine, devise, modify, plan
Evaluate	Judge value based on criteria, decision making	assess, conclude, contrast, evaluate
Analyse	Separate whole into parts until structure of whole and relation between parts is clear	analyze, infer examine, dissect ascertain,
Apply	**Use knowledge in a new situation. Involves rules, methods, laws.**	**Apply, calculate, solve, predict**
Understand	Grasp meaning, explain, interpret, translate, paraphrase of memorized info	Describe, Explain, Give example of, Select
Recall	Focuses on memorization and recall, reproduce	List, Identify, Define, State

Examples of learning objective at Apply Level

Student will be able to

- Derive expression for current in series or parallel circuits.
- Expected outcome—Students will be able to apply Ohm's law for series /parallel circuit for each section and then together they will come with voltage and current relation .

ACTIVITY: Write learning objectives for topic chosen



Course Name-
Module/Chapter-

Level	Learning Objectives
	At the end of this module, students will be able to
Apply	
Understand	
Recall	

ACTIVITY:
Write learning objectives for your course

SELF ASSESSMENT:

Participants – self-assess the objectives you wrote:

1. Did you start with: *The student will be able to …*

2. Did you use action verbs? (avoid understand/ know)

HIERARCHY OF LEARNING OBJECTIVES (HOTS)

Hierarchy of cognitive levels

Level	Description –Learning Level	Action Verbs
Create	Generate new ideas, products or ways of looking at things.	design, combine, devise, modify, plan
Evaluate	Judge value based on criteria, decision making	assess, conclude, contrast, evaluate
Analyse	**Separate whole into parts until structure of whole and relation between parts is clear**	**analyze, infer, examine, dissect, ascertain**
Apply	Use knowledge in a new situation. Involves rules, methods, laws.	Apply, calculate, solve, predict
Understand	Grasp meaning, explain, interpret, translate, paraphrase of memorized info	Describe, Explain, Give example of, Select
Recall	Focuses on memorization and recall, reproduce	List, Identify, Define, State

Examples of learning objective at Analyze Level

Student will able to

- Derive another law (Thevenin, Norton etc.) from Ohm's law.
- Expected outcome---Students should first apply Ohm's law in the given circuit and then write equations and prove various laws.

Hierarchy of cognitive levels

Level	Description –Learning Level	Action Verbs
Create	Generate new ideas, products or ways of looking at things.	design, combine, devise, modify, plan
Evaluate	**Judge value based on criteria, decision making**	**assess, conclude, contrast, evaluate**
Analyse	Separate whole into parts until structure of whole and relation between parts is clear	analyze, infer examine, dissect, ascertain
Apply	Use knowledge in a new situation. Involves rules, methods, laws.	Apply, calculate, solve, predict
Understand	Grasp meaning, explain, interpret, translate, paraphrase of memorized info	Describe, Explain, Give example of, Select
Recall	Focuses on memorization and recall, reproduce	List, Identify, Define, State

Examples of learning objective at Evaluate Level

Student will able to

- Decide best suitable circuit from given circuit to drive 7segment display.
- Expected outcome—Student should able to decide criteria to select circuits based on current values calculated using Ohm's law.

Hierarchy of cognitive levels

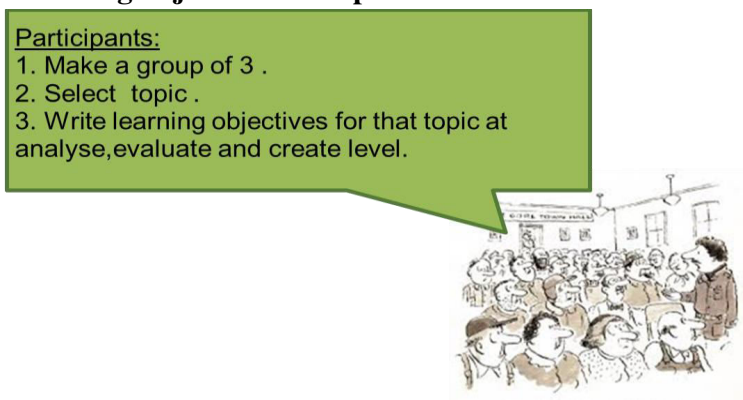
Level	Description –Learning Level	Action Verbs
Create	**Generate new ideas, products or ways of looking at things.**	**design, combine, devise, modify, plan**
Evaluate	Judge value based on criteria, decision making	assess, conclude, contrast, evaluate
Analyse	Separate whole into parts until structure of whole and relation between parts is clear	analyze, infer examine, dissect, ascertain
Apply	Use knowledge in a new situation. Involves rules, methods, laws.	Apply, calculate, solve, predict
Understand	Grasp meaning, explain, interpret, translate, paraphrase of memorized info	Describe, Explain, Give example of, Select
Recall	Focuses on memorization and recall, reproduce	List, Identify, Define, State

Examples of learning objective at Create Level

Student will able to

- Design a circuit for impedance matching.
- Expected outcome—Student should be able to select components based on power transfer which is calculated using Ohms law.

ACTIVITY: Write learning objectives for topic chosen



Course Name-
Module/Chapter-

Level	Learning Objectives
	At the end of this module, students will be able to
Create	
Evaluate	
Analyse	

MULTIPLE LEVELS OF LOS in a single topic

LEVEL	LO: Student should be able to
Recall	State hydrostatic law.
Understand	Draw static fluid pressure distribution on different surfaces.
Apply	Calculate the forces exerted by a fluid at rest on plane or curved submerged surfaces
Analyze	Examine (or infer about) the different cases of hydrostatic forces acting on surfaces submerged in a fluid.
Evaluate	Decide which type of surface is suitable for particular applications such as water dams, liquid storage tanks.
Create	Design an automatic gate system for liquid storage tanks.

LEVEL	LO: Student should be able to
Recall	Draw circuit diagram for voltage divider bias for CE amplifier
Understand	Calculate values of current and voltage for given circuit
Apply	Design voltage divider bias circuit for faithful amplification.
Analyze	Analyse given circuit for its various specifications..
Evaluate	Identify the best amplifier circuit for given applications
Create	Design a circuit for given application.

Hierarchy of cognitive levels—Summary

Level	Description –Learning Level	Action Verbs
Create	**Generate new ideas, products or ways of looking at things.**	**design, combine, devise, modify, plan**
Evaluate	Judge value based on criteria, decision making	assess, conclude, contrast, evaluate
Analyse	Separate whole into parts until structure of whole and relation between parts is clear	analyze, infer examine, dissect, ascertain
Apply	Use knowledge in a new situation. Involves rules, methods, laws.	Apply, calculate, solve, predict
Understand	Grasp meaning, explain, interpret, translate, paraphrase of memorized info	Describe, Explain, Give example of, Select
Recall	Focuses on memorization and recall, reproduce	List, Identify, Define, State

LEARNING OBJECTIVES- EXAMPLES

Analog Electronics: Amplifier circuits

Level	Learning Objectives
	At the end of this module, students will be able to
Create	Design a circuit for given application.
Evaluate	Identify the best amplifier circuit for given applications.
	Analyse given circuit for its various specifications..
Apply	Design voltage divider bias circuit for faithful amplification.
Understand	Calculate values of current and voltage for given circuit.
Recall	Draw circuit diagram for voltage divider bias for CE amplifier.

Caution: Only action verbs can not decide cognitive level of the task!

Caution: Only action verbs can not decide cognitive level of the task!

Different levels –Use of action Verbs

Are the following learning objectives lie at same level?

A. Students will be able to compare series and parallel circuits
B. Students will be able to compare pros and cons of using series and parallel circuits for given application.

1.Yes

2.NO

Rank the learning Objectives for learning levels

Choose correct option for order of following learning objectives

A. Students will be able to calculate values of current/voltage in the given circuits.
B. Students will be able to write expression for resistance for given circuit using Ohms law.
C. Students will be able to derive expression for other parameters such as power for given circuits.

1.A>B>C 2. B>A>C
3.C>B>A 4. C>A>B

ACTIVITY:

Write learning objectives for your course

SELF ASSESSMENT:

Participants – self-assess the objectives you wrote:

1. Did you start with: *The student will be able to …*
2. Did you use action verbs? (avoid understand/ know)

Assignment on Learning Objectives

- Select a Second topic from your course
- Decide expected outcomes for the lesson
- Write learning objectives at all levels.

Course name:-

Module name:-

Level	**Learning Objectives**
	At the end of this module, students will be able to
Create	
Evaluate	
Analyse	
Apply	
Understand	
Recall	

Alignment of Assessment Questions with Learning Objectives

Learning Objectives : Session Objectives

After this session you will be able to :

1. Classify the assessment questions as per Bloom's taxonomy.
2. Generate questions for different levels of Bloom's taxonomy.
3. Align the assessment questions to their respective learning objectives

Let's analyze a teaching- learning scenario

Scenario 1 : Teaching-Learning Scenario

What did the teacher do?

- Teacher selected topic of Laws of Motion
- She taught and explained the theory behind the laws
- She then solved a number of problems based on various equations in three laws of motion.
- She gave a number of similar numerical problems to students for practice.

What did the students do?

- Student practiced these problems
  - They were confident of solving numericals based on laws of motion.

What assessment question came?

There was an assessment test in which two of the questions were based on laws of motion as follows:

1) State the three laws of motion.
2) A block is given an initial velocity of 5.00 m/s up a frictionless 20.0° incline. How far up the incline does the block slide before coming to rest? Take g = 10 ms^{-2}.

Scenario 1 : **Assessment Result**

- Out of 60 students from the class
  - 2 students (Ram and Shyam were top scorers of the class)
  - They got excellent grades in the course

The story doesn't end here !!!

A few days later both Ram and Shyam appeared for the competitive exam where questions based on laws of motion were asked. When the results were declared……..

Ram fared fairly well but **Shyam miserably failed**

Think (Individually): *(Time – 2 mins.)*

What did you understand from scenario ?

Pair (Group activity): *(Time – 3 mins.)*

- Discuss your reasons with your neighbour
- Converge on most important understanding

Share (Group activity): *(Time – 3 mins.)*

- Share your group's reason with all of us.

Summarizing

'Good grades' achieved by students in exams need not indicate 'good learning'!

What is the solution?

Think (Individually): *(Time – 2 mins.)*

Write your answer for the question:

What solutions will you suggest so that good grades will always means good learning?

Pair (Group activity): *(Time – 3 mins.)*

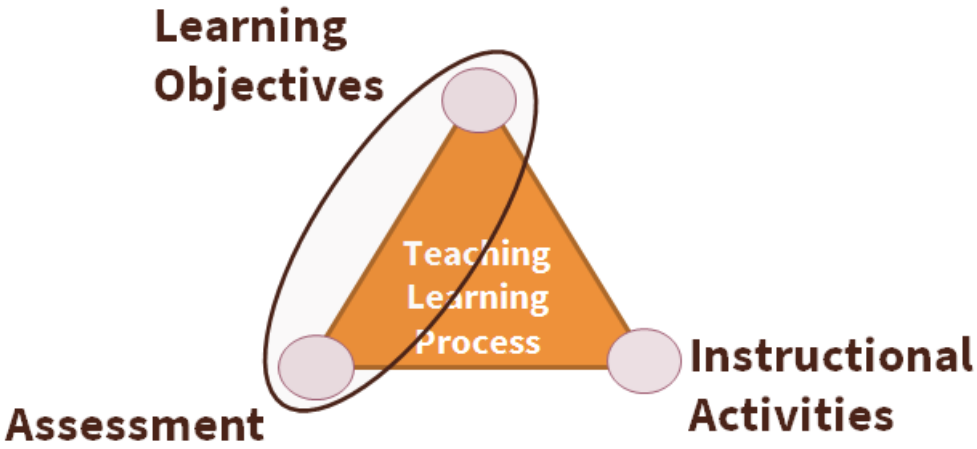
- Discuss your solutions with your neighbour

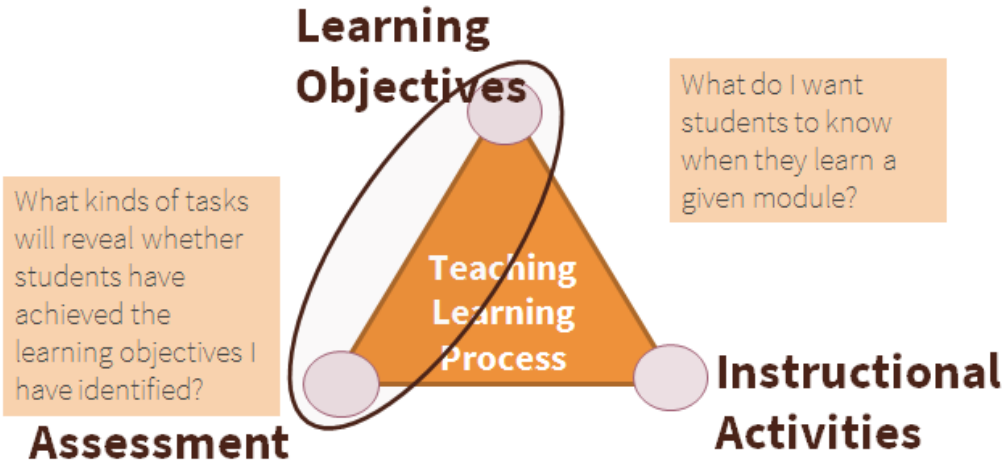
- Converge on the most important solution.

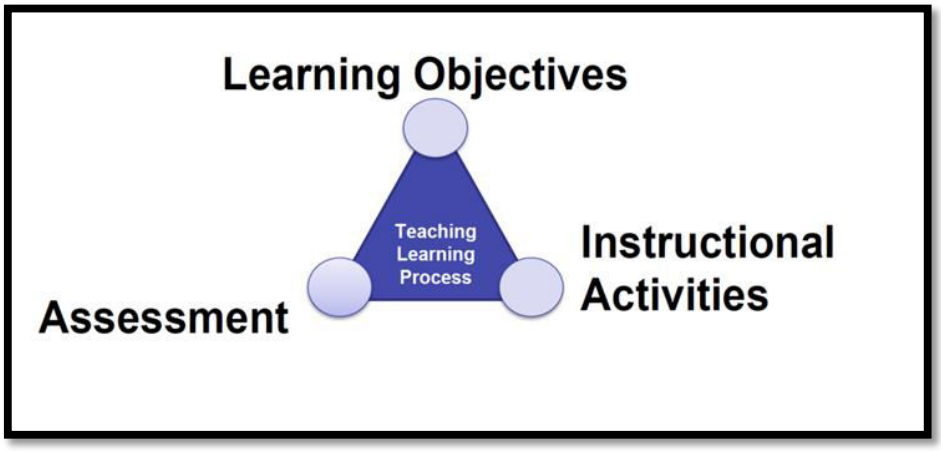
Share (Group activity): *(Time – 3 mins.)*

- Share your group's solution with all of us.

Effective Alignment of Assessment and Learning Objectives





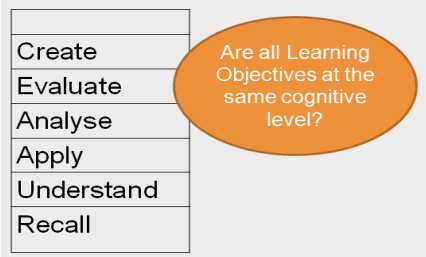


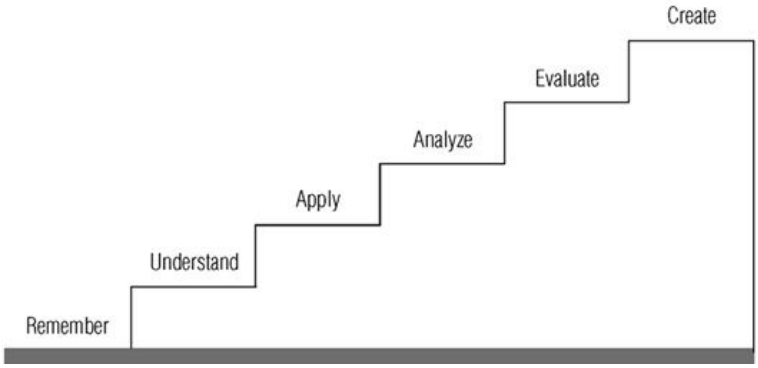
What do you mean by assessment?

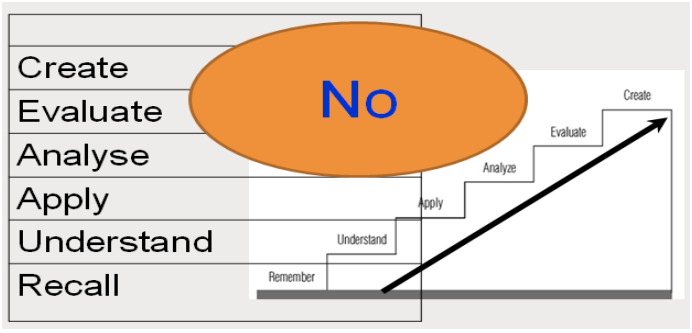
- Assessments should reveal how well students have learnt what we want them to learn.

Hierarchy of cognitive level

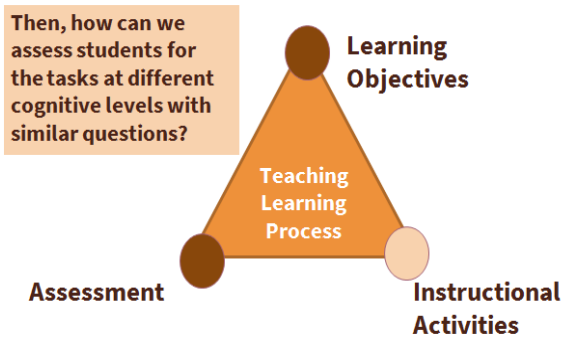
(Revised Bloom's taxonomy, Anderson & Krathwohl)

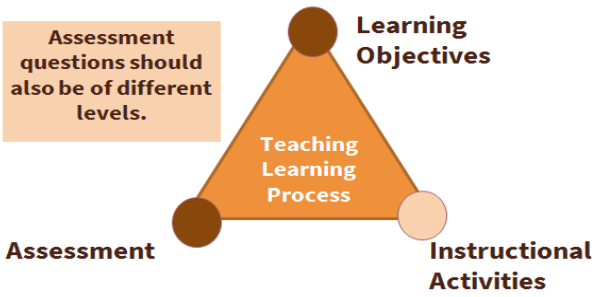






How to assess students?





Activity 2 : **Vote** Individually

Rank given assessment questions in terms of Bloom's taxonomy (from lower to higher levels)

1) Calculate current I using source transformation technique
2) State the condition for series resonance in an RLC circuit
3) Design a AC motor for a locomotive to drive a load of 50Te.
4) Find the impedance of a given complex RLC circuit

A. 1-2-3-4 B. 2-1-4-3
C. 1-4-2-3 D. None of these

Activity 2 : Discuss with your peer and **Vote** again
Activity 2 : Correct Answer

Rank given assessment questions in terms of Bloom's taxonomy (from lower to higher levels)

1) Calculate current I using source transformation technique
2) State the condition for series resonance in an RLC circuit
3) Design a AC motor for a locomotive to drive a load of 50Te.
4) Find the impedance of a given complex RLC circuit

A. 1-2-3-4 B. 2-1-4-3
C. 1-4-2-3 D. None of these

Aligning Assessment with Learning Objectives

What is the cognitive level of question?
The unit of resistance is _____.
1.R
2.U
3.A
4.AN
5.E
6.C

What is the cognitive level of question?

The unit of resistance is _____

Recall

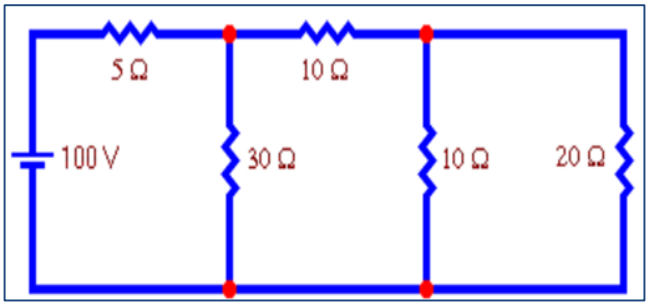
Recall	Recognize, recall facts. Remember previously learnt material.

Describe the working principle of a moving coil Galvanometer

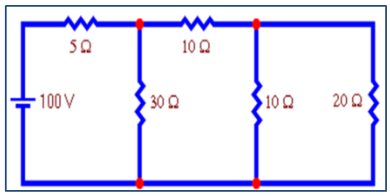
Understand

Understand	Grasp meaning, explain, interpret, translate, paraphrase of memorized information

Use nodal analysis to find the voltage at each node of this circuit



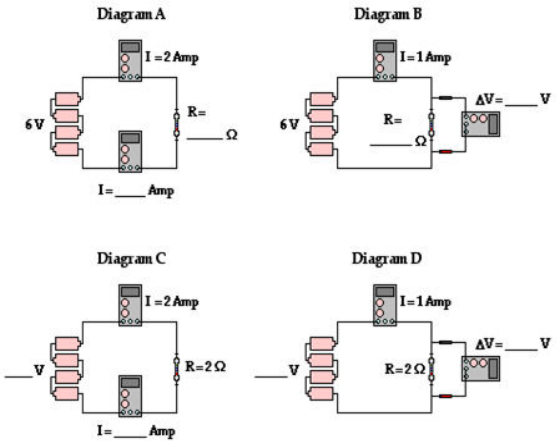
Use nodal analysis to find the voltage at each node of this circuit



Apply

Apply	Use knowledge in a new situation. Involves rules, methods, laws.

In the circuits of diagrams A, B, C, and D what method Has been used to control the current in the circuits?



In the circuits of diagrams A, B, C, and D what method Has been used to control the current in the circuits?

Analyze

Analyze	Separate whole into parts until structure of whole and relationship between parts is clear.

Examine (or infer about) the different cases of hydrostatic forces acting on surfaces submerged in a fluid.

Evaluate

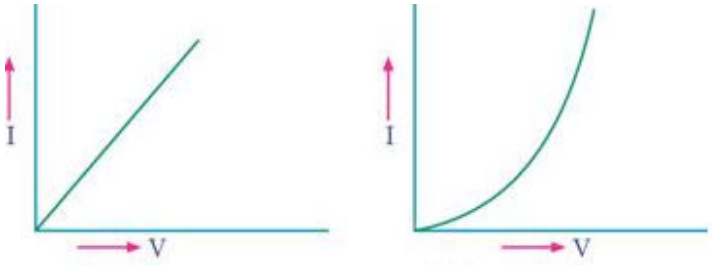
Evaluate	Judge value based on criteria, justify a Decision

Alignment of assessment with learning objectives

Is the assessment aligned with LO?

LO: Students should be able to draw V-I graph for Ohmic and Non-Ohmic resistors.

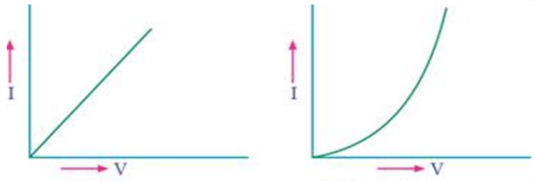
Q:Which of the given is a characteristic of Non-Ohmic resistance.



A. Yes B. No

LO: Students should be able to draw V-I graph for Ohmic and Non-Ohmic resistors.

Q:Which of the given is a characteristic of Non-Ohmic resistance.



A.Yes B. No

Q:Design a circuit that will reduce the given DC fan's rotation speed to 40 % of its current speed.

A. Yes B. No

LO: Students should be able to apply Ohm's law in simple series circuits.

Apply

Q:Design a circuit that will reduce the given DC fan's rotation speed to 40 % of its current speed.

Create

A.Yes B. No

LO: LO: Students should be able to calculate the resistance in the circuit from experimental observations of potential difference (V) and current (I).

Q: Write mathematical statement for Ohm's law.

A. Yes B. No

LO: Students should be able to calculate the resistance in the circuit from experimental observations of potential difference (V) and current (I).

Apply

Q: Write mathematical statement for Ohm's law.

Recall

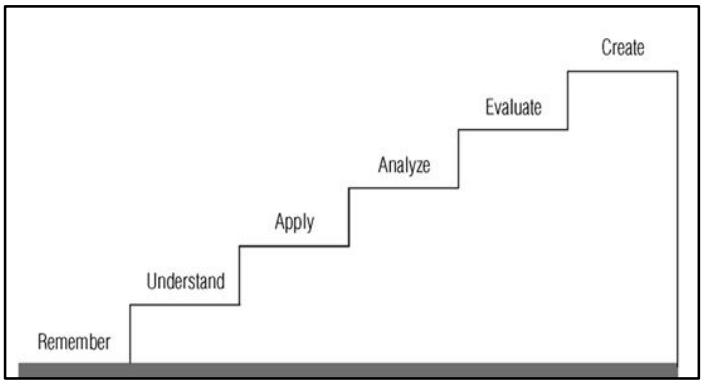
A. Yes B. No

Blooming all the way

What?

A series of questions in a given topic that go from Recall level to Create level.

Why? Create a question bank in various topics so that we can use them while framing assignments and exams.



Blooming all the way-Example

Subject: Maths (high school); Topic: Co-ordinate geometry

LEVEL	QUESTION
Recall	State the formula of Euclidean distance between two points.
Understand	Draw a diagram to explain the meaning of Euclidean distance.
Apply	What is the air-distance between Rashtrapati Bhavan and Red Fort, given their coordinates on the local map: (3, 18) & (4, 27).
Analyze	Ram flies in a helicopter from points A to B, then from B to C, then from C to D as shown on the diagram. How far is he from his starting point?
Evaluate	Decide if you would use the chessboard distance or the Euclidean distance to calculate the cost of the road connecting two towers A & B.
Create	Develop a program in Scratch that takes the values of the coordinates of two points, and output the distance between them.

Subject: Digital Logic (Engineering); Topic: Logic Gates

LEVEL	QUESTION
Recall	Draw the logic diagram for JK flipflop.
Understand	Give an example of a combinational circuit. OR, Complete the truth table for the given logic.
Apply	Simplify and draw the logic diagram for the expression:
Analyze	Reduce the number of gates in the given complex circuit.
Evaluate	Compare the error correcting capacity of CRC8 & CRC10.
Create	Design a counter to count objects of conveyer belt .

Designing Question Bank

Learning Objectives : Session Objectives
After this session you will be able to :

1. Generate questions for different levels of Bloom's taxonomy.
2. Create a question bank for a course

Goal: Design a series of questions for a topic in your course that span the six Bloom's levels.

- Find a partner from your domain.
- Choose a course that you both are comfortable teaching.
- Choose a topic, that you would need 2-3 class to teach.
- Write assessment questions, one in each Bloom's level, starting from Recall. [HINT – Use Action verbs]

NOTE –

1) The questions must be for the same topic.
2) Do not add a new topic when you write higher level questions.

Blueprint Design

University Assessment Scenario

- Five colleges affiliated to the university M offer a course on Data Structures in their second year engineering curriculum.
- Syllabus is designed by the university which also contained six course objectives covering all cognitive levels.
- Teachers taught the course in their respective colleges based on the syllabus and COs provided.
- At the end of the semester university conducted examinations. But the question paper which was received had many problems

At the end of the semester university conducted examinations. But the question paper which was received had many problems

All the questions covered only CO1 to CO4

Questions were only from LOTS.

There were no variety of questions

The consequence of this is that there was no way to **measure the attainment of CO5 and CO6**.

What is the Solution?

Before constructing a test, prepare a template, called a Blueprint

Blueprint, consisting of three dimensions:

- Content/Topic of Assessment (Modules/Units)
- Cognitive levels / learning objectives
- Types of questions

First, construct tables that assigns weightages (or marks) to items in each of the above three dimensions.

Then,

combine the three tables into a single table.

Table 1 with weightage assigned to different COs in a course

S. No.	Content Area	Weights	Marks
1	Declaration and Initialization of array	10%	5
2	Operation on arrays (insertion, deletion, traversal)	40%	20
3	Multidimensional arrays	20%	10
4	Array of structures	16%	8
5	Strings	14%	7
	TOTAL	100	50

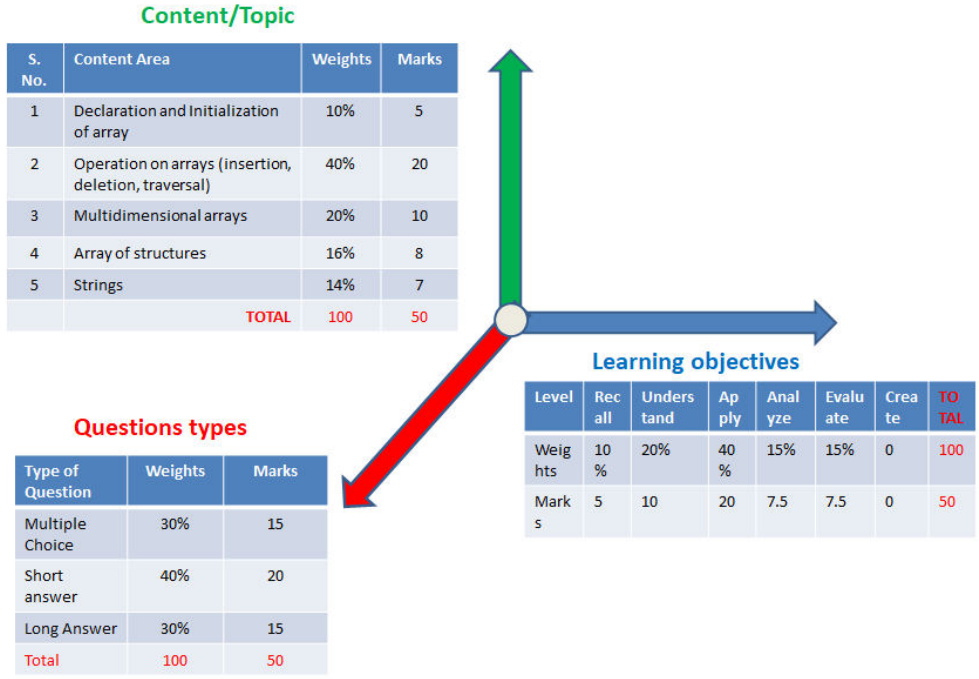
Table 2 with weightage assigned to different cognitive levels in a course

Level	Recall	Understand	Apply	Analyze	Evaluate	Create	TOTAL
Weights	10%	20%	40%	15%	15%	0	100
Marks	5	10	20	7.5	7.5	0	50

Table 3 with weightages assigned to different question types

Type of Question	**Weights**	**Marks**
Multiple Choice	30%	15
Short answer	40%	20
Long Answer	30%	15
Total	**100**	**50**

Three dimensions of Blueprint



COs	Objectives																		Total Marks
	Recall			Understand			Apply			Analyze			Evaluate			Create			
	MCQ	SHORT	LONG	MCQ	SHORT	LONG	MCQ	SHORT	LONG	MCQ	SHORT	LONG	MCQ	SHORT	LONG	MCQ	SHORT	LONG	
1	1	1	0	0	0	0	1	0	0	1	0	0	1	0	0	0	0	0	**5**
2	1	0	0	0	0	3	0	0	5	0	0	3	0	2	3	0	0	0	**17**
3	0	0	0	1	2	2	1	2	0	0	1	0	1	0	0	0	0	0	**10**
4	0	2	0	1	0	0	1	1	0	0	0	0	1	2	0	0	0	0	**8**
5	0	0	0	1	2	0	1	2	3	1	0	0	0	0	0	0	0	0	**10**
Total	**2**	**3**	**0**	**3**	**4**	**5**	**4**	**5**	**8**	**2**	**1**	**3**	**3**	**4**	**3**	**0**	**0**	**0**	**50**
	5			12			17			6			10			0			

Group Activity : Analyzing Question Paper

- ❑ Find a partner from your domain.

- ❑ Choose a course that you both are comfortable teaching.
- ❑ Read the question paper in your course.
- ❑ Find the weightages assigned to different types of COs, cognitive levels and question type.
- ❑ Create table 1, table 2 and table 3

Step 1-Tag Question paper

Sr.No	Questions	Marks	Co/Module/topic	Learning level(RBT)	Type of Question

Step 2-Complete following table

COs	**Objectives**																		**Total Marks**
	Recall			**Understand**			**Apply**			**Analyze**			**Evaluate**			**Create**			
	MCQ	**SHORT**	**LONG**	**MCQ**	**SHORT**	**LONG**	**MCQ**	**SHORT**	**LONG**	**MCQ**	**SHORT**	**LONG**	**MCQ**	**SHORT**	**LONG**	**MCQ**	**SHORT**	**LONG**	
1																			
2																			
3																			
4																			
5																			
Total																			

Reflection

Are you satisfied with the Blueprint emerged from question paper?

Discuss with your group – why or why not?

Designing Question Paper

Learning Objectives : Session Objectives

After this session you will be able to :

1. Generate a Blueprint for a given course.
2. Create a question paper as per the generated Blueprint

Activity : Designing Blueprint

- ❑ Find a partner from your domain.
- ❑ Choose a course that you both are comfortable.
- ❑ Design a blueprint for the test (50 marks) for your course.
- ❑ Design a question paper from the blueprint accordingly

Create a presentation containing at least 5 slides which will have

- ❑ Table with weightages assigned to different COs, cognitive levels and question types
- ❑ Blueprint with all the above dimensions
- ❑ Question paper as per the created Blueprint

Pedagogic techniques – Teaching and Learning methods

Peer Instruction (PI)

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The principles and methods of instruction
The activities of educating or instructing; activities that impart knowledge or skill
Why pedagogy?
Quality of life
Measured according to Human Development
Index (HDI)

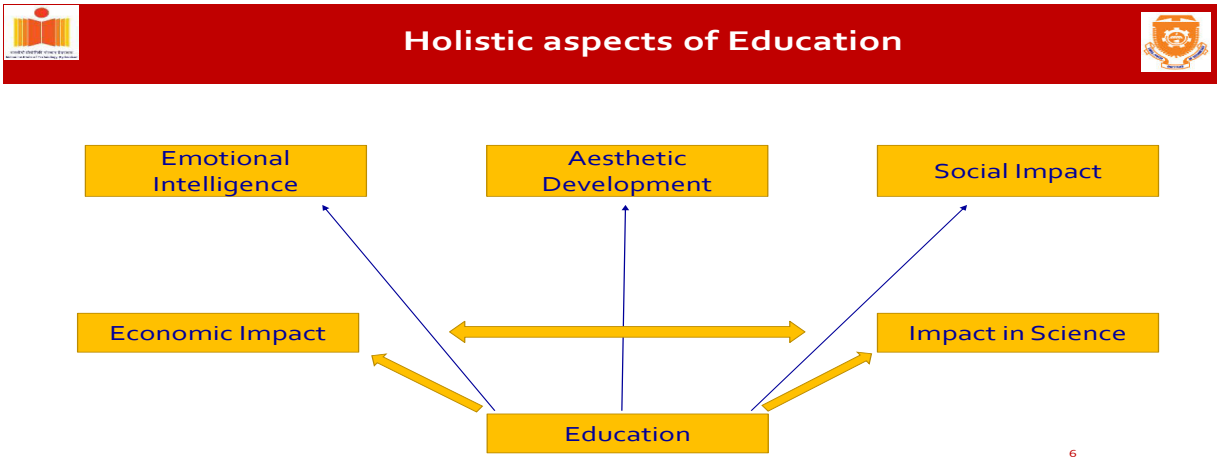
HDI is a summary measure of average achievements in key dimensions of human development

- A long healthy life
- Being knowledgeable
- Have a decent standard of living

Education : Acquisition of an ability to live in the world with a balanced optimum of

- Skill acquisition
- Intellectual
- Emotional and
- Sensual interaction

Holistic aspects of Education



Outcome Based Education in STEM

Higher educational reforms strongly emphasis an implementation of an **outcome based education** in all the **S**cience **T**echnology **E**ngineering **M**athematics (**STEM**) disciplines

Aligning course content – information delivery – assessment
In OBE it is essential to Implement integrated active learning pedagogies

Think – Pair – Share , Flipped classroom, collaborative learning:
Peer Instruction, peer tutoring, reciprocal teaching, cooperative - Jig-saw method ,problem solving, Project-based learning, etc

- Does Active Learning Work? A Review of the Research ,J. Engr. Education, 93(3), 223-231 (2004).
- Active Learning: Creating Excitement in the Classroom. (1991) ASHE-ERIC Higher Education Reports.

7

Introduction

"Active inquiry, not passive absorption is what engages students. It should pervade the curriculum" Johnson et al. 1989, 68

Traditional lecturing versus Active Learning

Teachers are **information** providers	Teachers are **facilitators**
Students are mostly **PASSIVE** listeners	Students are **ACTIVE** learners
CONTENT is the king	**OUTCOMES** are the king
Typically a **LINEAR** progression	Iterative **SPIRAL** progression
Assessments are contrived and tests separate and **discrete areas**	Assessments are real-life like and **test multiple areas**

Hake, Richard R (1998) "Interactive engagement vs. traditional methods", American Journal of Physics, 66, 64-74.

8

Challenges / Hurdles

Today's class room

- Large class rooms – lecture settings
- Some / Many students tune out
- Engage in distractions (mobiles / Talking)
- Talking on off task-topics

An important goal in such a setting is to keep students engaged with the content, the instructor and each other.

9

Keeping Engaged

Student engagement is one of the most widely researched indicators of the **attractiveness** of the teaching-learning process.

Desirable goal – to keep students engaged with the teaching process

What is engagement in a class? - Defining it has been elusive

Three major types of student engagement in the class room

Cognitive engagement : creativity, synthesis, analysis and reflective thinking
Behavioral engagement : participation in academic and social activities
Emotional engagement : positive and negative responses to people and class activities

10

Operationalized in different ways

- student satisfaction,
- enjoyment
- involvement in learning
- classroom participation
- perseverance

Peer Instruction (PI)

Peer Instruction is a class room active learning strategy based on specific, well-designed questions

Peer instruction / learning – known to be one among the most effective techniques to keep students "engaged"

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What dress would you suggest to a tourist, who is visiting Hyderabad during summer?

a) Tight fit black dress
b) Tight fit white dress
c) Loose fit black dress

Loose fit white dress
Now discuss with your neighbors / peers

What dress would you suggest to a tourist, who is visiting Hyderabad during summer?

a) Tight fit black dress
b) Tight fit white dress
c) Large fit black dress
d) Large fit white dress

Did anyone changed your answer ? What you just did is peer learning?

Flow of Peer instruction

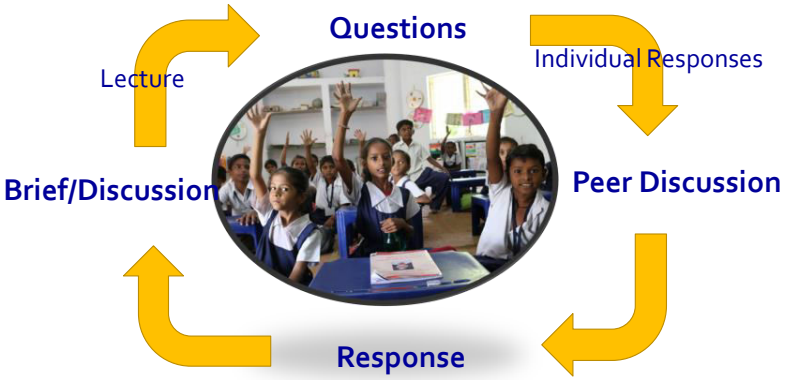

Figure recreated from Prof. Sahana Murthy – IIT Mumbai. Original source Stephanie Chasteen and the Science education Initiative at the university of Colorado

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Think Pair Share

Closer Examination:

What exactly did you do? (if you may consider yourself as student)

Pair – Turn to your neighbor

Write two specific actions that students (you) did. Do not simply say we solved the problem

Share – Discuss with entire class, facilitated by coordinator.

Come with a list of behaviors that a student does during the Peer- Instruction activity.

ILLUSTRATION

Choose one unique problem that you think most of us face.

Provide two valid points on why do you think so?

Merits and Demerits of online courses

Merits	De-merits
Access to experts Professional friendly Work and study possibility Make aware of latest technologies	Isolation – considered as major drawback Access to instant online tools – no perseverance Maneuver text books, course materials - copy paste and Ctrl+F Characteristic activities and higher order thinking – mandates the educator

21

Debate

Debate: Is multiple choice questions good?

Group A (yes)	Group B (No)
Evaluation of concepts Precise knowledge is reflected Training for future exams Nurturing deep thinking Uniformity across the domain Elimination is easier Efficient utilization of time Effectiveness in evaluation	More scope for copying Learning is peripheral Confusion for students Lack of analytical thinking Low quality Tempted to random pick True / complete evaluation is hindered MCQs are random sampling

23

Debate

Debate: Is multiple choice questions good?

Group A (yes)	Group B (No)
Evaluation of concepts Precise knowledge is reflected Training for future exams Nurturing deep thinking Uniformity across the domain Elimination is easier Efficient utilization of time Effectiveness in evaluation	More scope for copying Learning is peripheral Confusion for students Lack of analytical thinking Low quality Tempted to random pick True / complete evaluation is hindered MCQs are random sampling

23

Is multiple choice questions good?

Group A (yes)	Group B (No)
Assessment of large classes Shuffling of questions – to curb copying Modern tools No bias in evaluation Analysis of wrong answers possible Time management Domain knowledge without soft skills Negative marking to avoid randomness Training for national level examinations Go green	Cannot analyze knowledge Copying is promoted Random answers with limited knowledge No depth studies Limited with framework of questions No improvement in writing skills

22

Generic discussion on TPS

What do students do in the process?

- Talk to each other
- Listen to their classmates
- Argue about the content
- Reason, solve steps of the problem
- Write or draw to solve the problem

Dissecting Peer-Instruction method

What do they do? What are the benefits?

- Talk, argue, listen (sometimes), reason, draw => Actively engaged
- Learn from each other, teach each other (teach <-> learn)
- Those who don't know – willing to think, reason, answer
- Those who do know also participate

Pre-existing thinking is elicited, confronted, resolved

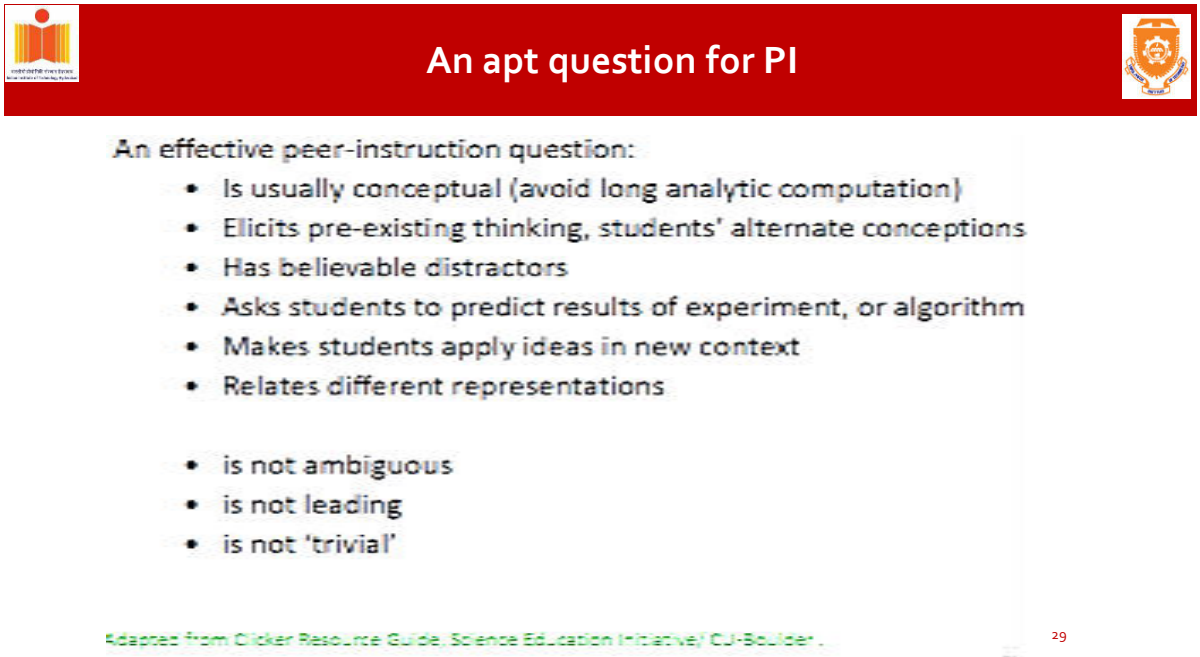
Benefits to Instructor and class atmosphere

Immediate feedback to instructor
Students realize that even others are struggling
Builds a friendly, yet scientific atmosphere
Improve communication

Requirements of Peer learning

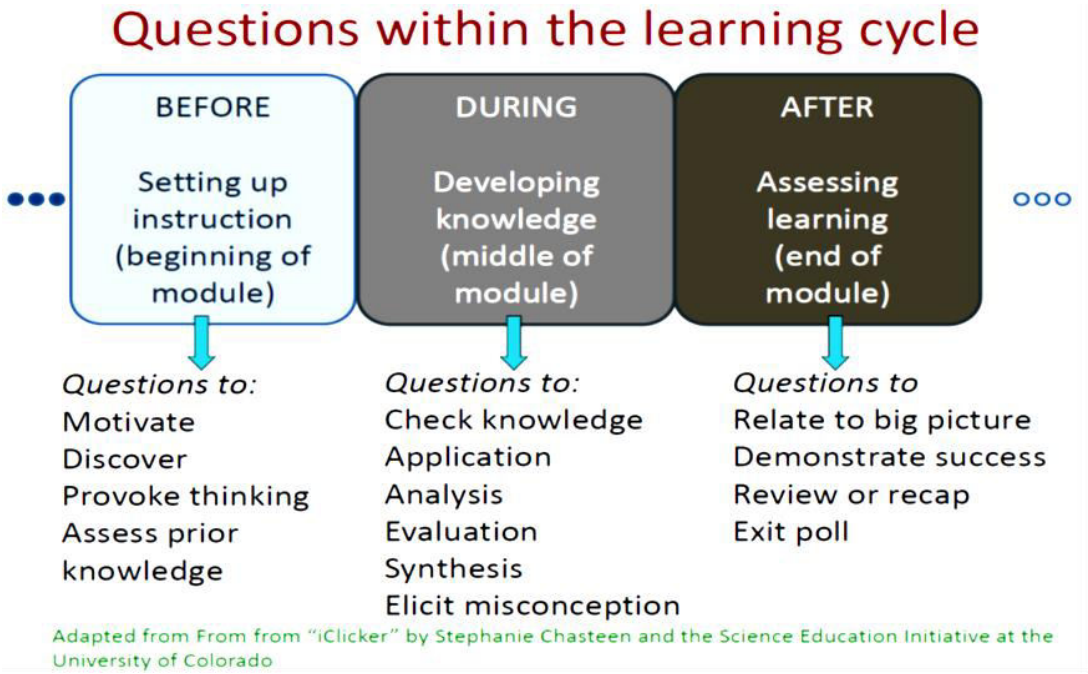
carefully designed activities
- require students to talk, write, reflect and express their thinking

Majority go beyond listening, copying of notes and/or execution of prescribed procedures



Key Elements of Peer Instruction

- Students engage in problem-solving activities during class time
- The problems posed are in a variety of contexts, often real life
- Specific student ideas are elicited and addressed
- Students are asked to "Figure things out of themselves"
- Students work collaboratively
- Students receive rapid feedback on their work
- Qualitative reasoning and conceptual thinking are emphasized



Challenges

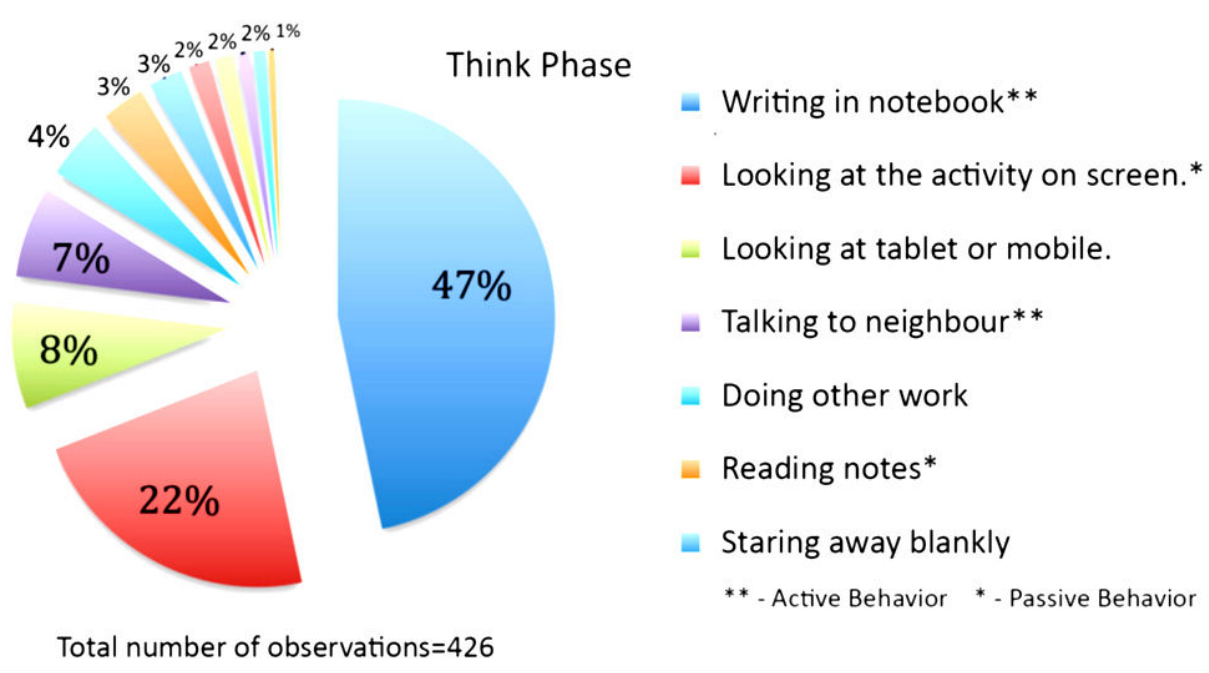
The class is too quiet, The class is too noisy, Some students just may not participate, Students may not know how to reason, The class will get chaotic. How do I get them back?

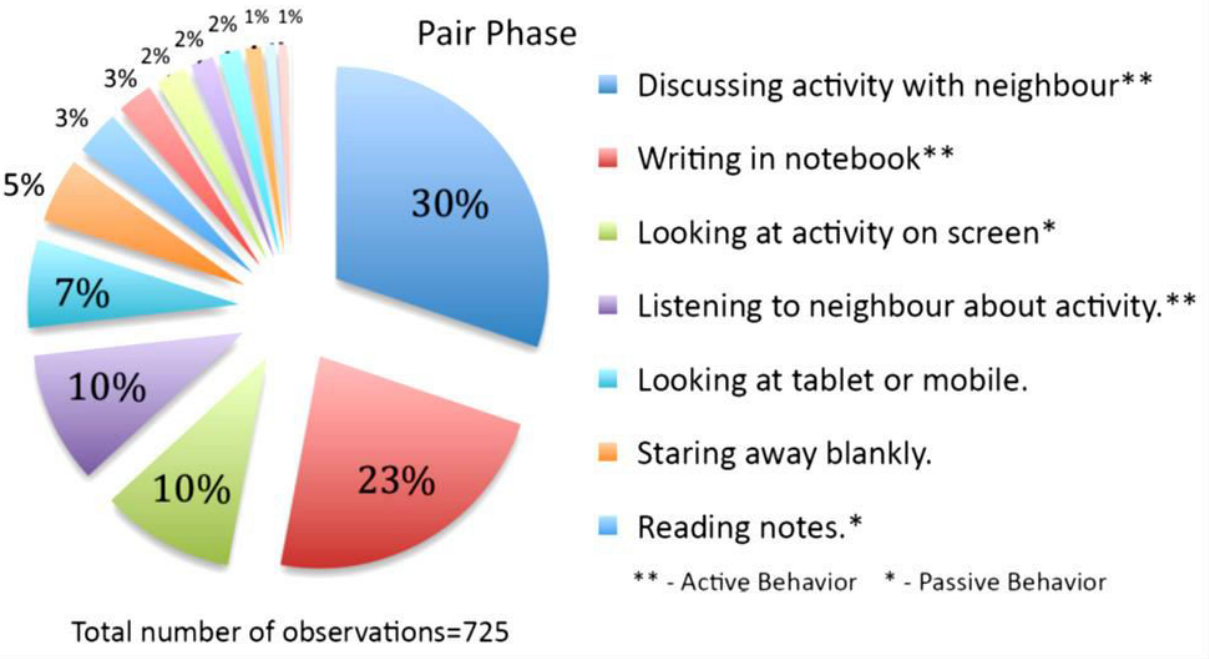
Recommended strategies

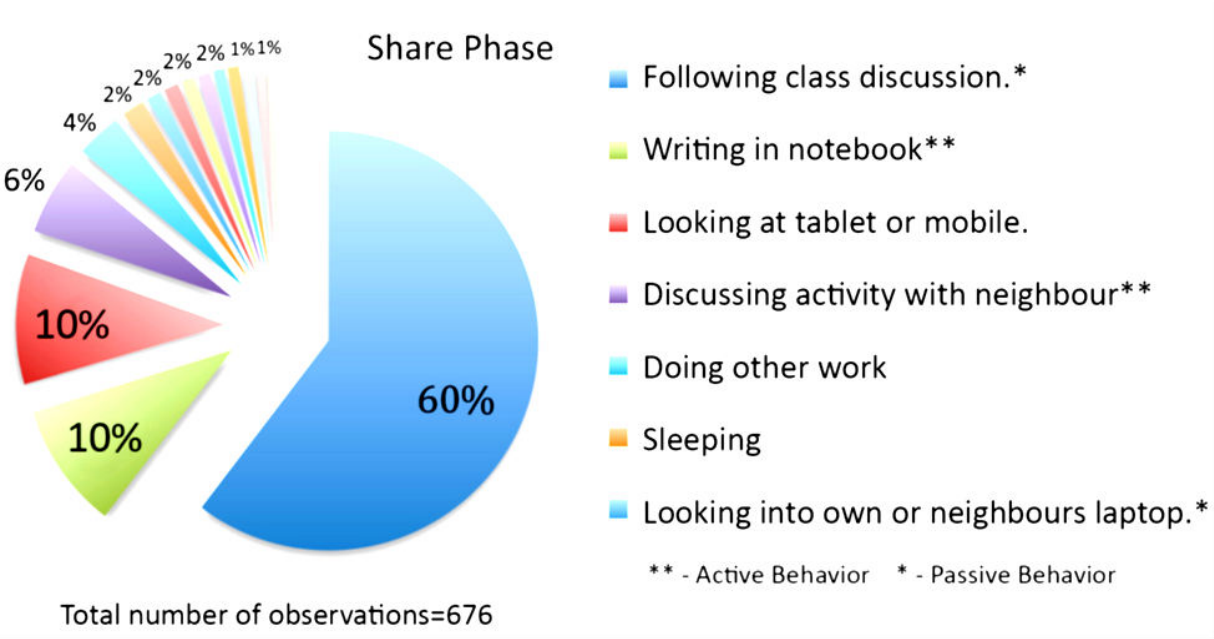
- Be patient – students' reluctance to discuss omproves after 3-4 iterations. It is ok, it is good noise. Most students are seen to be on task
- Take solo response – provide enough time
- Explain why you do this – use challenging & interesting questions… let them be
- This might not be true, provided questions are designed well
- Use some kind of sound to restore attention

Rigorous analysis of the outcome of TPS

Aditi K, Rwitajit M, Sahana M, Sridhar I, ICER'13, August 12–14, 2013, San Diego, California, USA.


Think Phase
47%
22%
8%
7%
4%
3%
3%
2%
2%
2%
1%
Writing in notebook**
Looking at the activity on screen.*
Looking at tablet or mobile.
Talking to neighbour**
Doing other work
Reading notes*
Staring away blankly
** - Active Behavior
* - Passive Behavior
Total number of observations=426


Pair Phase
30%
23%
10%
10%
7%
5%
3%
3%
2%
2%
2%
1%
1%
Discussing activity with neighbour**
Writing in notebook**
Looking at activity on screen*
Listening to neighbour about activity.**
Looking at tablet or mobile.
Staring away blankly.
Reading notes.*
** - Active Behavior
* - Passive Behavior
Total number of observations=725



No. of students = 228	Think	Pair	Share
Fully engaged	71.83%	62.03%	68.43%
Mostly engaged	9.86%	21.23%	16.57%
Sometimes engaged	2.91%	9.53%	7.00%
Never engaged	15.39%	7.21%	8.01%

- Extent of research
  - 300+ research articles
  - Physics, biology, chemistry maths, CS, engineering, psychology, medicine & nursing ...
  - Many controlled studies using standardized tests
- Courses using peer instruction outperform traditional lecture courses on a common test
- Students can better answer a question on their own, after peer instruction discussion, (especially difficult questions) – study with 16 pairs of isomorphic questions *Smith et al, Science 2009*
- Research on student perception says: clickers help students show up for class, feel part of class community, make their voice heard, hold them accountable ...

Prof. B. V. Appa Rao
Teaching-Learning Centre, NIT Warangal

Dr. B.V. Appa Rao delivered his lecture on Best Practices and Case Studies in Teaching and Learning to enhance Quality of Engineering Education in Day – 2, afternoon session. In his lecture he overview about quality, standard, Student- Centred Paradigm, and Best Practices in Teaching and Learning. The presentation of the session is given below,

Difference between Quality and Standards

- 'Quality' relates to process (e.g., the quality of the educational process experienced by students)
- 'standards' relate to the product (eg., intended or actual achievement of learning outcome in terms of knowledge and skills)
- Linking quality and standards: contribution of educational process (quality) to attainment of a defined standard

Quality: The Curriculum, Infrastructural facilities, teaching methods implemented, assessment methods used, the overall students' learning experiences (Process)

Standards: The students' learning outcomes in the Programme in the Cognitive, Psychomotor and affective domains. (Product)
The teachers have to design and implement the process (Quality) in order to achieve the desired product (Standard).

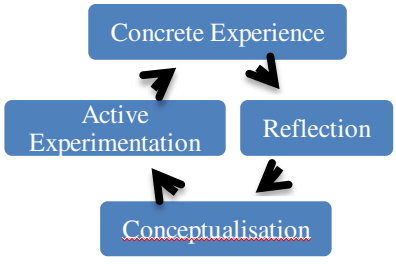
The new paradigm of Engineering Education: Student- Centred Paradigm

- This is activity-based, activities carried out by the students.
- Teacher plans the activities by involving students.
- Facilitates the implementation of activities. Guides, Motivates and inspires the students during Learning Process

Student-centred Engg. Education takes into account the need to:

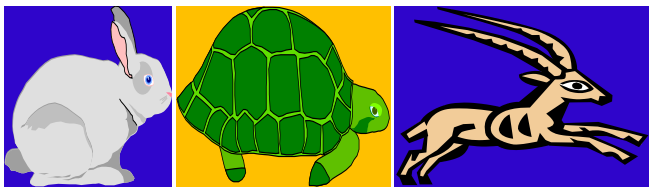
- know and develop whole personality of learner
- enhance/facilitate learning
- foster critical and sustainable thinking
- promote experiential learning
- emphasize learning through active participation
- promote collaboration and team work

KOLB'S LEARNING CYCLE



Why focus teaching on the learner?

Students learn at different rates . . . .

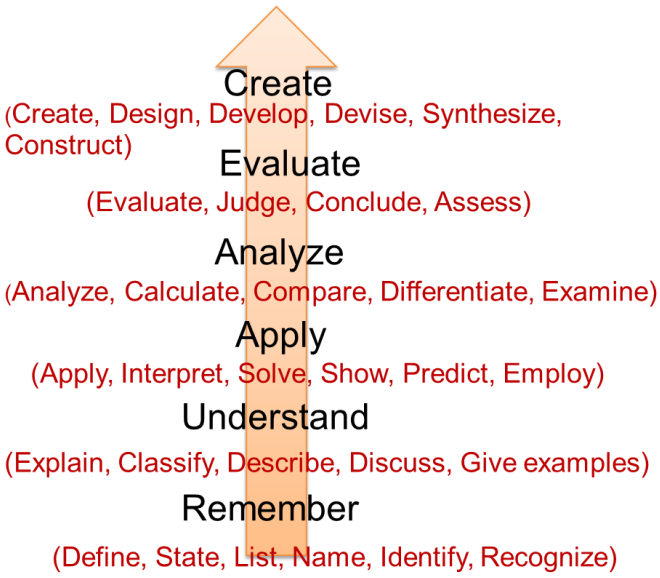


- Learning styles are different
- Sensory/ Intuitive
- Visual/ Auditory/ Kinaesthetic (physical activities)
- Inductive/Deductive
- Active/Reflective
- Sequential/Global
- Approaches to learning, Pace of intellectual development are different

Ref: Understanding Student Differences, Richard Felder & Rebecca Brent, J. Engineering Education, 94(1), 57-72, (2005).

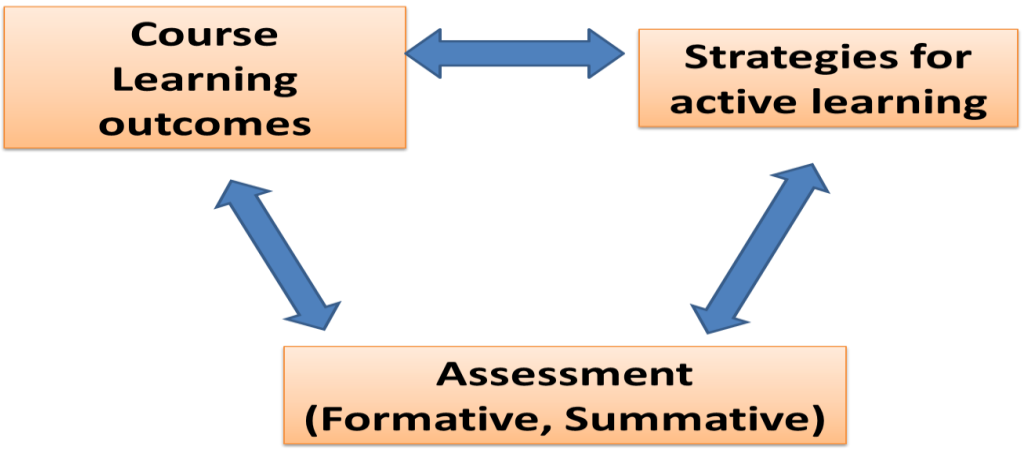
Learn from the learner
"Instruction begins when you, the teacher, learn from the learner. Put yourself in his place so that you may understand what he learns and the way he understands it"
---Kierkegard (1813-1855)

Anderson's revised Bloom's taxonomy of course objectives & related verb forms



In order to facilitate the Learning Outcomes among Students as per Course Outcomes, we must learn

- Subject Knowledge(Mastery)
- Pedagogy(Appropriate teaching methods)
- Integrating ICT in Teaching & Learning

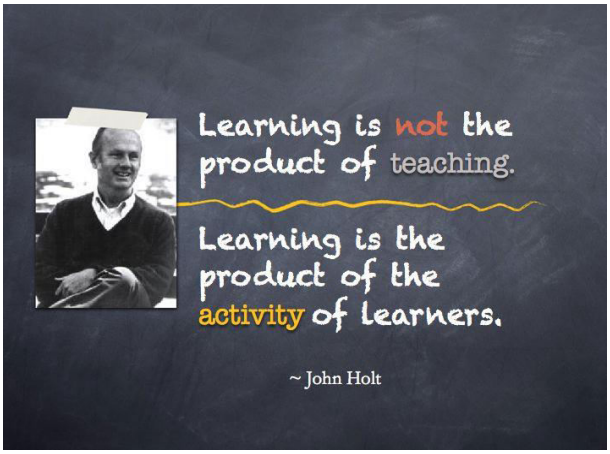


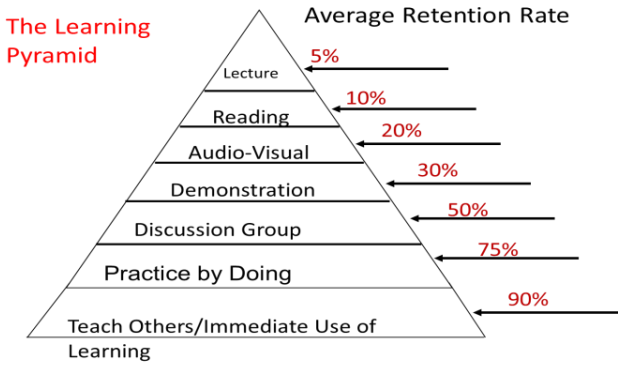
Active Learning : Definition

Active learning is defined as any instructional method that engages students in the learning process.

In short, active learning requires students to do meaningful learning activities and think about what they are doing'

(Ref: Bonwell, C.C and J. A. Eison, " Active Learning: creating excitement in the class room", ASHE ERIC Higher Education Report No. 1, George Washington University, Washington, DC, 1991)





Some of the Best Practices in Teaching and Learning

- Learning by doing
- Learning through discussion among the peer group
- Learning through Case Studies
- Group Projects
- Through Field Studies
- Problem Oriented Guided Inquiry Learning(POGIL)
- Experiential Learning
- Reflective Learning
- One Minute Paper during the classroom interaction
- Open ended questions by teacher
- Open ended questions from students
- Question Bowl taken around the class by the teacher or one of the students
- Preparation of question bank by students at various cognitive levels

Learning by Doing

- Use of Free and Open Source Software (FOSS)

Spoken Tutorials of IIT Bombay(Web site: www.spoken-tutorial.org)

For 3D modeling:

FreeCAD is the most important free and open source alternative in place of commercial softwares

(Ref.: University of Alaska, MIT, Virginia Tech, Harward university, California Institute of Technology etc.)

- Octave is the Linux- Community solution for MATLAB
- SciLab is another alternative for MATLAB, very strongly advocated by IIT Bombay and other Institutions.
- FreeMat Provides environment similar to MATLAB for data processing and analysis
- LinuxCNC controls CNC machines. It can drive milling machines, lathes, 3d printers, laser cutters, plasma cutters, robot arms, hexapods, and more.

Blender
An industrial design tool that is better suited to quick ideation and rendering.
Blender is free design software for any purpose.
Blender is an open source project that aids industrial designers in visualization.

High tech design software and 3D printers:
Mechanical Engineering Students in undergraduate dynamics courses will no longer have to puzzle over two dimensional textbook drawings of dynamic components.

Instead, they'll reproduce those static drawings in CAD , create the actual parts with 3D printers, then design and create a dynamic mechanism from scratch using these same innovative technologies.

These new approaches will allow the students to more easily connect basic engineering concepts with their practical applications in real world engineering.

Spatial intelligence
Spatial intelligence is the ability to draw precise conclusions by observing a three-dimensional environment. This involves analyzing and interpreting the size, shape, movement and relationships between surrounding objects.

It is also used when figuring out maps and taking part in any kind of construction or engineering project.

According to scientific research, 3D designing enhances a student's spatial intelligence. It not only triggers one's imagination but also helps in bringing imaginations to life.

3D printing has the ability to create tangible activities through which students can learn important academic concepts such as

buoyancy through a working motorboat and

project motion through designing a 3D printed catapult.

- With the help of 3D printing technology, students can design and print subject models such as a skeleton to understand bone formation or an anatomical heart.
- It enhances the visualization skills and simultaneously adds a fun element to the learning experience.
- Also, students get a chance to make mistakes, learn and rectify it, which only augments the learning process.

Igniting innovation
3D printing Technology ignites imagination, and helps the students to bring their ideas to life.
Students grow beyond academics and stay on top of their game, constantly exploring and thinking out-of-the-box.

"**Achieving better outcomes through improved pedagogy and assessment is a real priority…" Edward Berger, University of Virgenia School of Engineering and Applied Sciences, USA**

- Pedagogical innovation using 3D printer technology promises to improve learning for young engineering students in the Department of Mechanical & Aerospace Engineering.

Use of Free and Open Source Software in teaching Hydraulics Design Course

A plug-in for Quantum GIS (QGIS) that allows you to create EPANET hydraulic analysis models.

EPANET is a popular open source software to analyze water supply networks.

Free and Open Source – Big Data Processing Tools

Apache Storm

Apache Hadoop

Apache Samoa

- Geospatial technologies (GSTs) have been reported as effective and useful instructional tools to improve students' learning and enhance their critical thinking, spatial thinking, and problem solving skills.(Higher order thinking skills)
- Selection of appropriate Geospatial tool for the given course content with the given course objectives is important

Case Study as Active learning Strategy

- Can be used in all subjects In Science, Engineering and Management
- For learning at higher cognitive levels

Examples of Case Studies for active learning of the topic 'Corrosion'

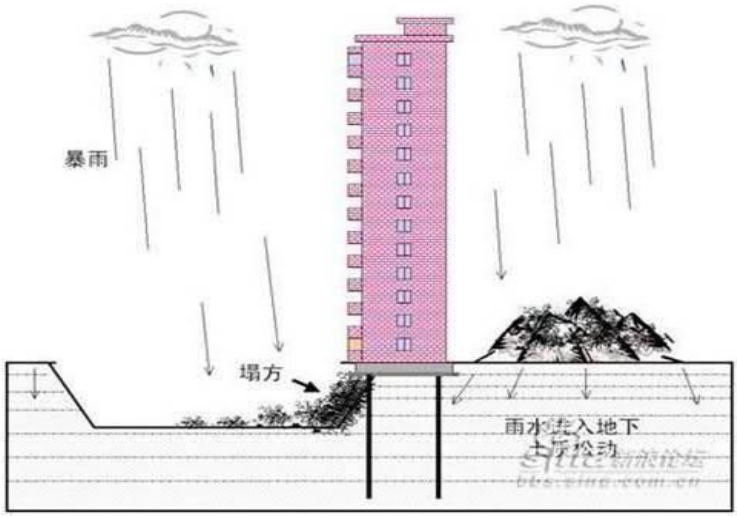
- Bhopal gas tragedy,
- Visakhapatnam oil refinery pipe line explosion,
- petroleum pipe line catching fire in East Godavari district of A. P
- corrosion problem in swimming pool,
- corrosion problems in bridges, ships, building structures in the form of real time photographs
- Teaching and Learning of Geotechnical engineering can be made more interesting with the use of Field Visits to construction projects and Case Studies

Ref: Role of Case Histories on Geotechnical Engineering Teaching and Practice, R. Shivashankar, NITK, Surathkal, Inida, seventh International Conference on 'Case Histories in Geotechnical Engineering', Chicago, April 29- 4 May, 2013.

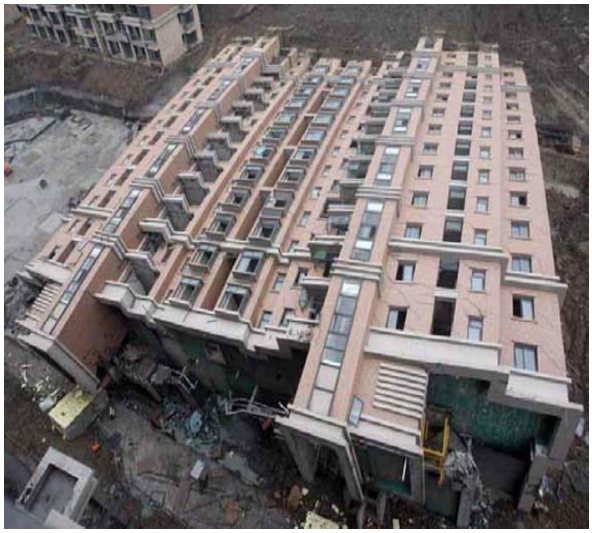
Geotechnical Investigation at Site

Case Study of Failure of Pile Foundation

- The failure could be said due to improper/bad geotechnical engineering practices. The piled foundation was supporting a multistoried building in Shanghai in China.
- The failure occurred due to excavated soft clayey soil on one side, being piled up on the other side of the building (Figs. In next slides).
- Details of this case study are available in a number of references on the internet/google search (for ex. Subramanian, 2009).



Schematic representation of failure of building in Shanghai in China (Subramanian, 2009)



View of building after failure (Subramanian, 2009)

Dunmore Bridge at Woodville, Australia

Ref: Dunmore Bridge Case Study: An introduction to Geotechnical Engineering via Finite Element Analysis, A.J. Abbo & S.G. Fityus, School of Engineering, University of Newcastle, Callaghan, Australia,S. Mackenzie, Coffey Geotechnics, Warabrook, Australia

ABSTRACT: 'This paper describes the development of a case study based upon the preliminary design of a working platform to support a 1200T crane during the replacement of bridge spans on the historic Dunmore Bridge (Woodville, NSW, Australia).

The case study was developed to enrich the teaching of finite element methods to undergraduate students by exposing students to practical aspects of finite element modeling

Learning through discussion

1. Think- Pair- Share Activity (TPS)

Q1 : Unknown Problem on a topic in the given course is to be given by the teacher (higher cognitive levels, Apply and above)

Designing the problem or question needs special effort

Think Phase: Suggested duration (3 minutes)

- *Teacher's activity*: Teacher will pose the above problem and ask every student to think and analyse the problem.
- *Students' activity*: Every student thinks, analyses the problem.

Pair phase: suggested duration (5 minutes)

- *Teacher's activity*: Teacher will ask the students to pair up and exchange their ideas and finally write their analysis of the problem and also plausible solution.
- *Students' activity*: Students discuss in pairs and each pair writes the analysis of the problem and the possible solution.

Share Phase: Suggested duration (10 minutes)

- *Teacher's activity*: The teacher asks each pair to present solutions. He facilitates discussion and leads the students toward deep learning.
- *Students'activity:* Students ask challenging questions, come out with original ideas and lead the entire class toward deep learning.
- At the end of this strategy, the teacher and students experience that new knowledge is constructed in the class room by the students. (Constructivist Approach)
- Teacher plays the role of motivator and facilitator toward deep learning.

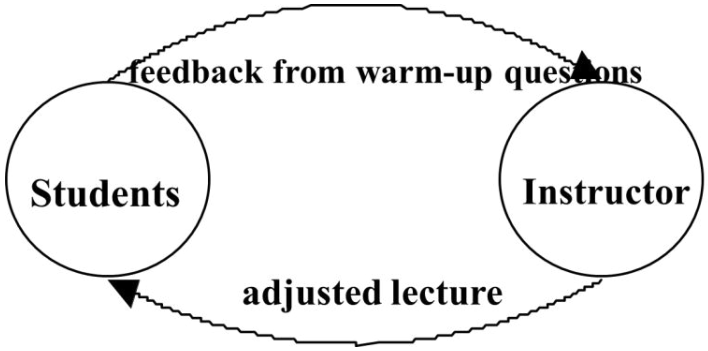
Then several new problems (real world problems) may be given as Group assignments to be done at home

Teacher has to inform the students in advance that only when the students are involved in solving the problems and learn the subject at higher cognitive levels, they will be able to perform well in the end semester or mid semester exams, achieve a better grade and get a suitable job after B.Tech. This is very important.

Example of a typical think-pair-share exercise used in the VLSI course.

Design a CMOS inverter to have a threshold voltage midway between its power supply voltage and ground. The CMOS process has minimum channel length of 0.5µm and minimum channel width of 1.5µm. Assume V_{TN}= -V_{TP}=0.5V, L_N=L_P, and μ_e=2μ_h. How does your answer change if the power supply voltage changes? How does your answer change if μ_e=3μ_h?

Ref: Active and Cooperative Learning in a VLSI Design Course: Lessons from the Trenches
J.W. Bruce , Department of Electrical and Computer Engineering, Mississippi State University, 2005 ASEE Southeast Section Conference



Just – In– Time Teaching (JiTT) method

Ref: Active Learning through: Just-in-Time Teaching in Digital System Design ,Guoping Wang, American Society for Engineering Education,2007, pages 12.171.1-9

Instructional Design for Outcomes - Based Learning : A Case Study

Course: 'Corrosion Science', an open elective for the B.Tech students(4th year)
Topic: Corrosion due to differential aeration cells

Teaching Learning Process: Three Phases

1. Motivation Phase
2. Information Phase
3. Active Learning Phase

Motivation Phase

- lecturing with interesting examples and applications from day-to-day experiences, anecdotes,
- demonstrating an experiment,
- presentation of a case study,
- challenging the students with open ended questions followed by discussion will motivate students toward learning a given topic.
- Finally, the students are asked to write their reflections on the relevance of the topic in about 3-4 minutes and submit the same to the teacher.

A few strategies for motivating the students toward the topic ' Corrosion'

Case studies like Bhopal gas tragedy, Visakhapatnam oil refinery pipe line explosion, petroleum pipe line catching fire in East Godavari district of Andhra Pradesh, corrosion problem in swimming pool, corrosion problems in bridges, ships, building structures can be presented in the form of real time photographs and analysed in order to bring home the severity of the problem of corrosion and its impact on economics and humans

- A demonstration experiment on corrosion of iron (using iron nails) in sodium chloride can be organized by involving a few students.
- The teacher can then sum up by saying that by learning the basic principles of corrosion and preventive methods deeply, the problem of corrosion can be tackled.

- Motivation to learn 'corrosion due to differential aeration cells' with practical examples and case studies of single metal corrosion by showing photographs through PPT.

Information phase - Out of class activity design:

- After the motivation phase, the teacher prepares the students for the out of class activities.
- These activities include studying videos prepared by the teacher himself and the other videos on the topic available (in you tube or other online resources) followed by answering the questions given in the assignment.

In the present case, videos on galvanic corrosion and corrosion due to differential aeration cells are prepared by the teacher by 'Screen-Cast-O-Matic' tool and the links of the videos are given hereunder.

1.Galvanic corrosion by B.V.Appa Rao Video link in youtube, https:youtu.be/AwCz4qQExIE

2. Corrosion due to differential aeration cells by B.V.Appa Rao, https://youtu.be/g-fHrESboQk.

Learning outcomes (L.Os) of Out-of-Class Activity:

1. Define corrosion of a metal due to differential aeration cells (Cognitive level : remember)
2. Explain corrosion of a metal due to differential aeration cells using electrochemical reactions (Cognitive level: Understand)

Table 1. Assessment of learning outcomes after studying learning material in the videos

L.O.	Assessment Question
1	Define corrosion due to differential aeration cells.
1	Which type of cell causes corrosion in case of a single metal?
2	In case of corrosion due to differential aeration how does formation of anode and cathode occur?
2	Consider the case of corrosion of iron due to differential aeration cells. Write the anodic and cathodic reactions
2	Consider the case of a zinc metal partially immersed in NaCl solution. Explain what happens in corrosion point of view.
2	Consider the case of iron bars kept in the open atmosphere. Explain why and how they undergo corrosion?
2	Differentiate between uniform corrosion and pitting corrosion
2	Pitting corrosion occurs when the anodic area is……the cathodic area
2	Why is pitting corrosion more dangerous than uniform corrosion?

Active Learning Phase: In-class Activity Design:

Learning Outcomes of In-Class Activity:

1. Analyse the practical corrosion problem due to differential aeration cells and find out the cause and origin of the problem
2. Evaluate different solutions to practical problem of corrosion due to differential aeration cells.

Case Study 1,

Q1: Observe the figure 1 shown below. Stainless steel flange and seal used, are shown. Stainless steel flange fitted with a seal is exposed to saline water. You can see that a part of stainless steel has undergone corrosion while some part has not corroded. Analyze this case and explain the type of corrosion in detail.

Q2: Suggest a method of prevention of corrosion in this case.

Stainless steel flange and seal used, related to case study 1

Case Study 2

Q3: Study the figure 2, which shows corrosion of underground pipe line carrying petroleum from offshore well to the refinery. Petroleum drained off at several points, causing a heavy loss and closure of the refinery's operations for some time.

Analyze the case, find out the type of corrosion and the cause of corrosion.

Corrosion of underground pipeline carrying petroleum. This figure is related to case study 2

Small Group Projects for Cooperative Learning

- Such projects done by the students promote active learning and many other inter personal skills. Scaffolding of the slow learners by the peers is also possible.
- Interdisciplinary and multidisciplinary projects related to design problems lead to innovations and even building up prototypes.

How to promote learning in slow learners?

Variety of assignments of three different categories, A, B and C.

Category A for everybody in the class (knowledge level only)

Category B also for everybody in the class (Understand level),

Category C (Apply and higher cognitive levels).

All must be given opportunity to solve these also. However, if even slow learners are able to solve 50% of them independently, that is fine. They must include some problems, which challenge the fast learners.

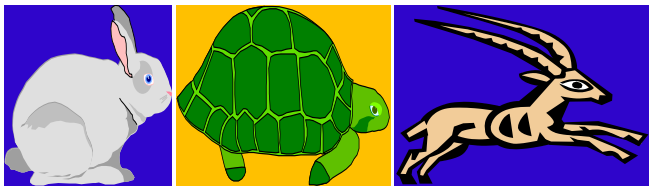
- Filling the gaps in pre requisite knowledge by conducting a pre-test before the beginning of teaching the course , giving them a set of problems to be solved (Pre-course assignment) and
- organizing peer-group instruction to fill the pre- requisite knowledge gap
- Tutorials in small groups(20 or less)

Cognitive Scaffolding Technique - Very useful for slow learners

For moving from the evidence to implementing effective teaching and learning practices to promote active learning among students

Lot of systematic effort is needed.

Why focus teaching on the learner?



People learn at different rates . . . .

- Learning style
- Sensory/ Intuitive, Visual/ Auditory/ kinaesthetic
- Inductive/Deductive, Active/Reflective
- Sequential/Global
- Approaches to learning, Pace of intellectual development

To Conclude

A Teacher, who facilitates active learning among students, becomes an active learner herself / himself. She / He experiences grains of discoveries in many projects.

She / He mentor generations of students, who can become innovators, entrepreneurs, leaders, administrators and teachers.

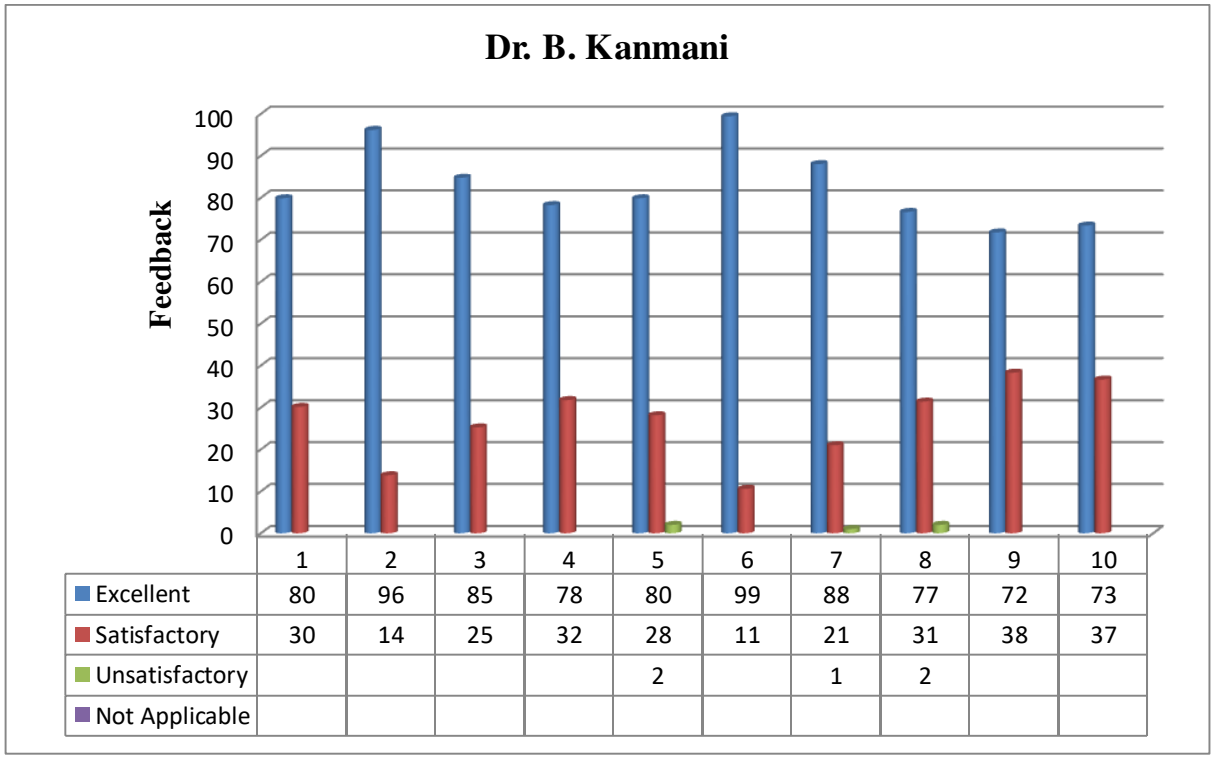
My tributes are to such great teachers

Feedback Analysis of Participants

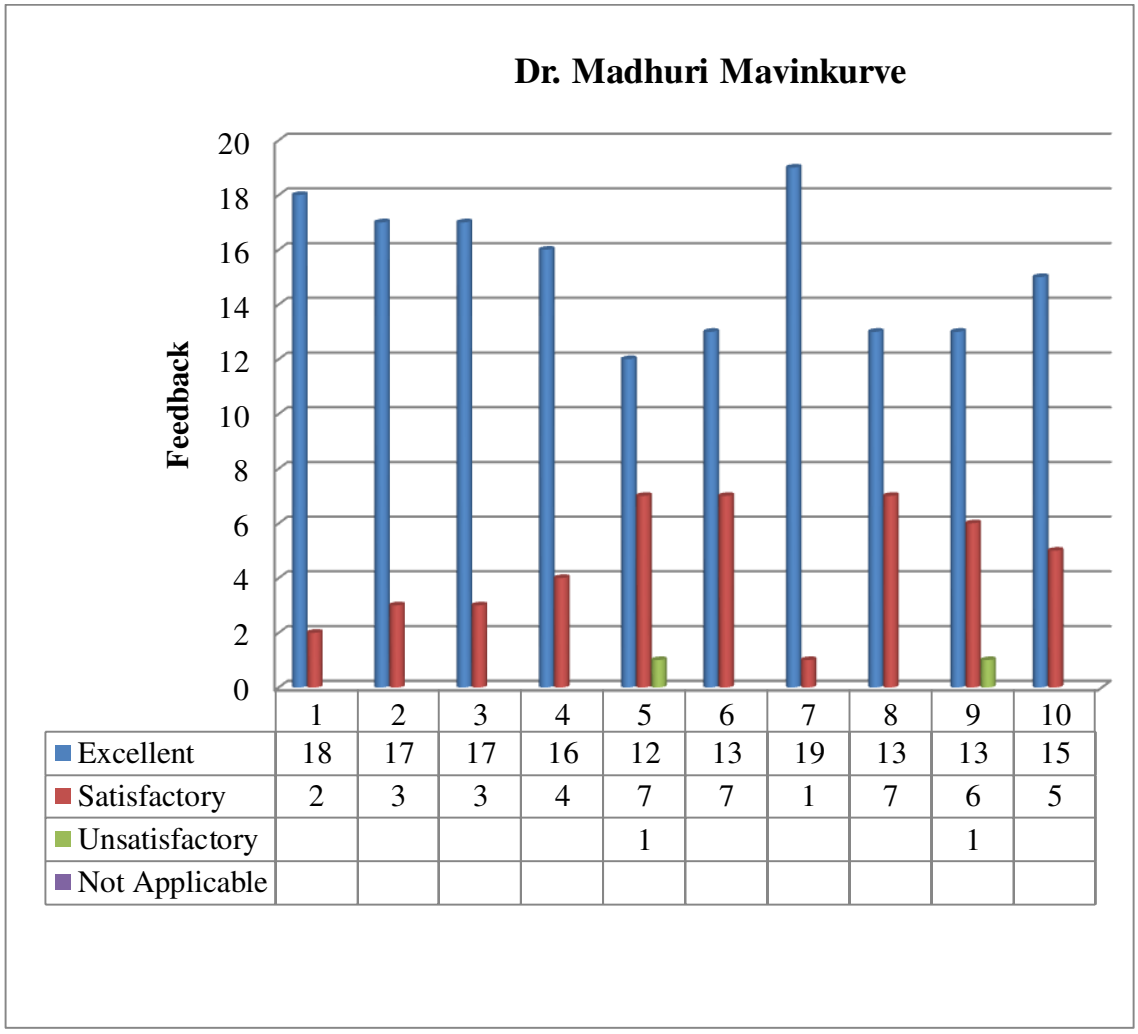
Day -1, Parallel 2 session conducted one session is conducted by the resource person **Dr.B.Kanmani**, Dean-Academics, Professor, BMS College of Engineering, Bangalore and another session is conducted by the resource person **Dr. Madhuri Mavinkurve**, ET Practioner & Trainer, Mumbai. Total 130 participants have attended the seminar. 110 participants attended Dr.B.Kanmani madam session and remaining 20 participants attended Dr. Madhuri Mavinkurve session. The feedback taken from the participants and the analysis is given below.

The following parameters are considered for the analysis.

S. No	Parameters	Excellent	Satisfactory	Unsatisfactory	Not Applicable
1	The objectives of the workshop are met				
2	Resource person is knowledgeable about the topics				
3	Clarity of instructions/questions				
4	Contents are organized in good manner				
5	Time allotment for the session was sufficient				
6	Resource person was a good communicator				
7	Participation and interaction are encouraged				
8	Topics covered are relevant to me				
9	Helped develop understanding of new principles or concepts				
10	Helped to develop new skills				

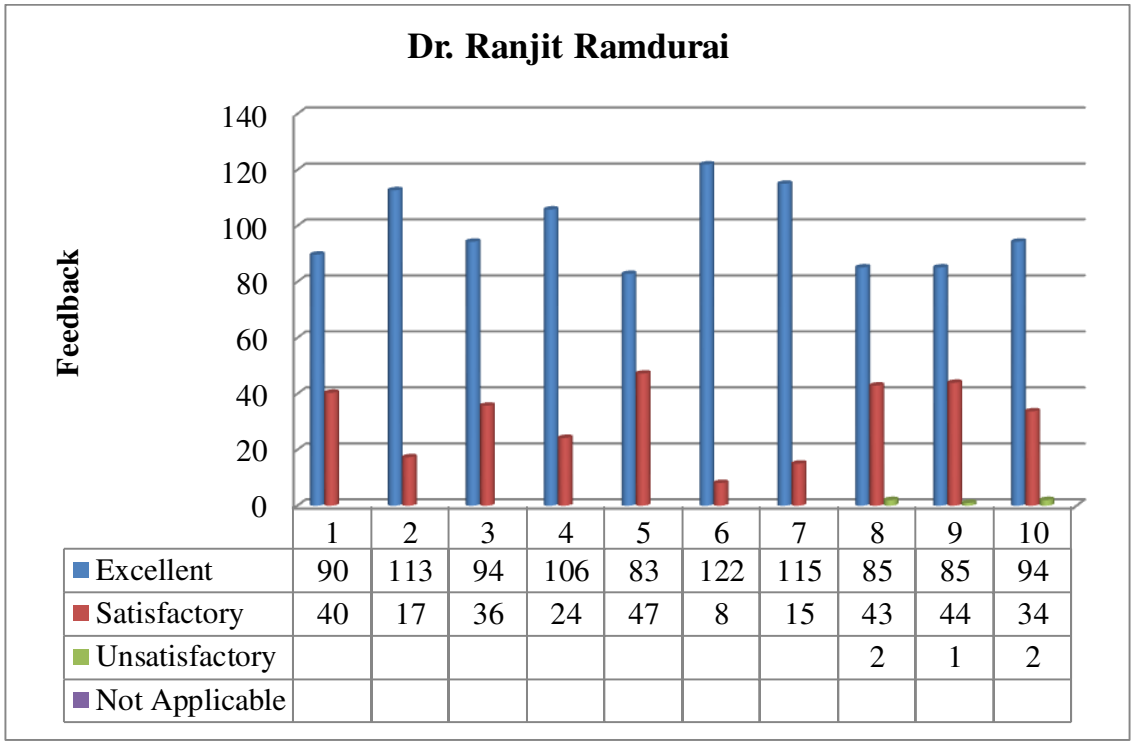


	1	2	3	4	5	6	7	8	9	10
Excellent	80	96	85	78	80	99	88	77	72	73
Satisfactory	30	14	25	32	28	11	21	31	38	37
Unsatisfactory					2		1	2		
Not Applicable										

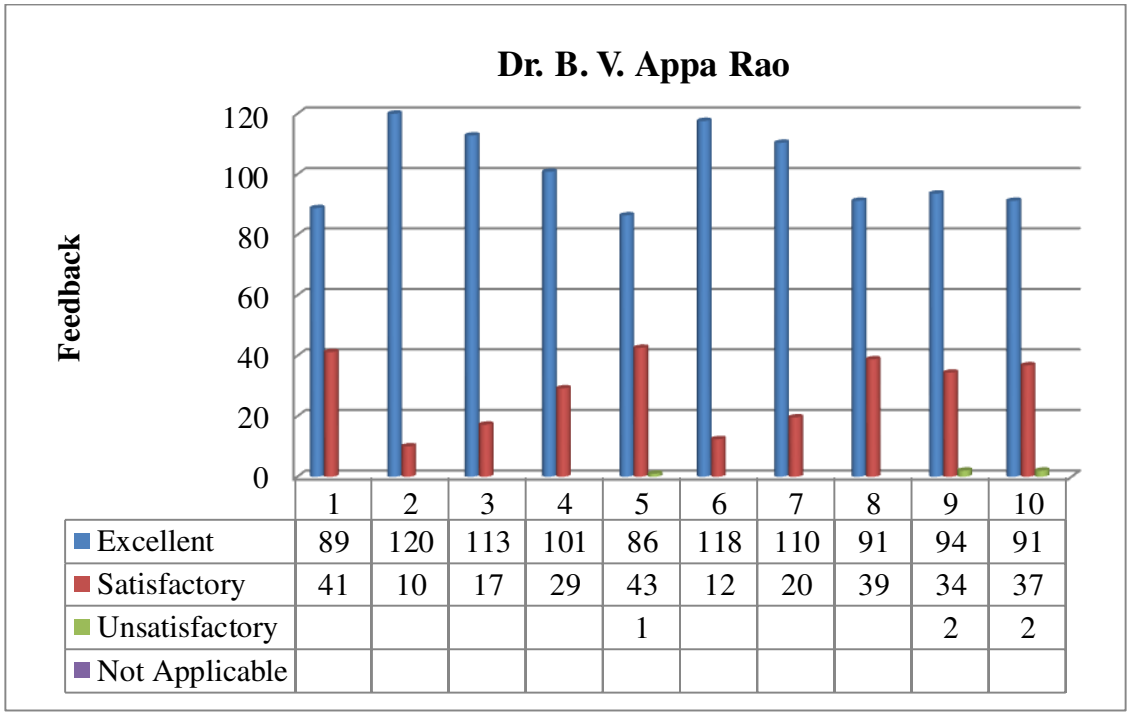


	1	2	3	4	5	6	7	8	9	10
Excellent	18	17	17	16	12	13	19	13	13	15
Satisfactory	2	3	3	4	7	7	1	7	6	5
Unsatisfactory					1				1	
Not Applicable										

Day – 2, forenoon session is conducted by the resource person **Dr. RanjithRamdurai**, Associate Professor & Head of the Department of Engineering Science, IIT Hyderabad. 130 participants have attended the sessions and given their feedback the analysis is given below. Afternoon session is conducted by the resource person **Dr. B. V. Appa Rao**, Research Fellow (Emeritus), Teaching Learning Center (TLC), NIT, Warangal. 130 participants have attended the sessions and given their feedback the analysis is given below

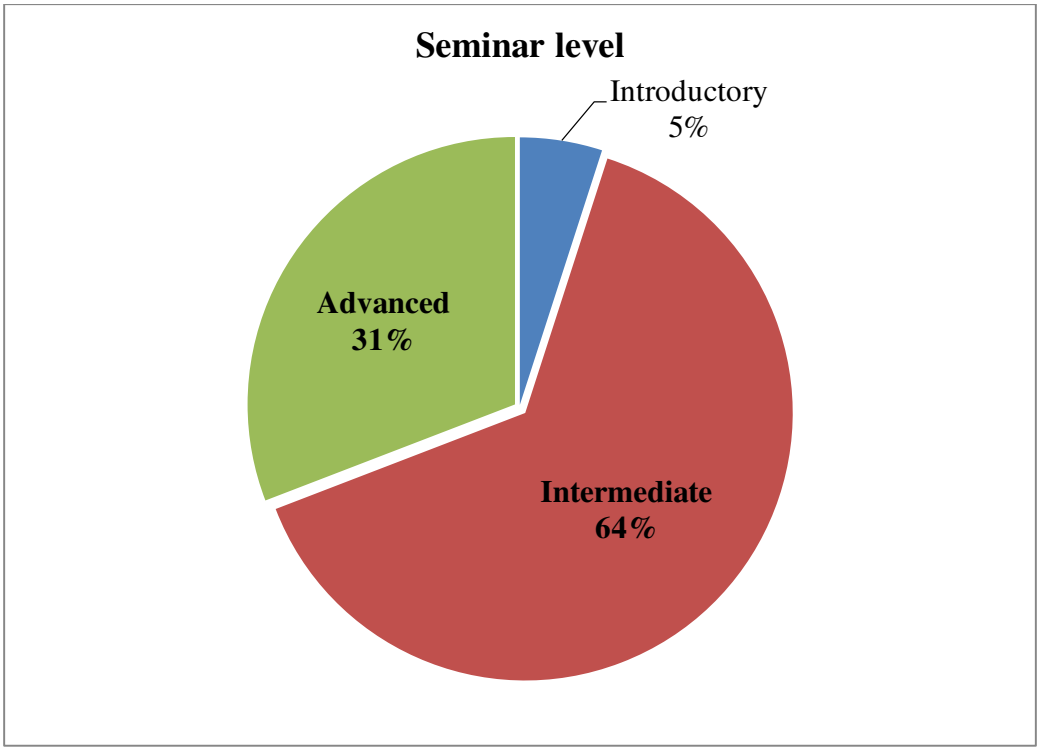


	1	2	3	4	5	6	7	8	9	10
Excellent	90	113	94	106	83	122	115	85	85	94
Satisfactory	40	17	36	24	47	8	15	43	44	34
Unsatisfactory								2	1	2
Not Applicable										



	1	2	3	4	5	6	7	8	9	10
Excellent	89	120	113	101	86	118	110	91	94	91
Satisfactory	41	10	17	29	43	12	20	39	34	37
Unsatisfactory					1				2	2
Not Applicable										

The overall feedback for the seminar is taken from the participants. The three parameters for the Level of Seminar are Introductory, Intermediate and Advanced level are considered. The analysis of the feedback is given below



The suggestion from the participants are collected for further action may be taken to make this efforts more effective and presentations more attractive in the future.

Topics that could have been added/ deleted (with reference to the program presented)

- Please share the documents to be thought beforehand.
- CO-PO attainment methods
- Pedagogy
- ICT for assessment to be included
- Along with OBE you have to add the calculation of course assessments and course assessment value.
- More Teaching and Learning Practices if possible

Any other suggestions

- Session is too lengthy without break should have been short and crisp.
- OBE is explained well
- Hands on session is might be helpful

- As I belong to H&S dept. relatively related examples did not come even languages level of mapping is understood to a certain extent.
- Plicker concept was new to me and I liked it very much and very soon I will implement in my class.
- Some practical difficulties are there to implement the OBE

Please indicate the topics, areas in which you may be interested to take training in future

- CO-PO mapping
- The future "Environment Sustainability with modern tools usage
- Teaching Learning methods
- Request to conduct seminars / workshops on latest technologies
- Framing of PEOs
- Attainment of POs and PSOs
- Mini project implementation for B.Tech
- Introducing non-credit courses
- Scientific English for journal article writing
- Blooms taxonomy
- Seminar on Thermal Engineering, Hear transfer
- Machine learning tools, algorithms
- Topics on how to make the students to interact and show interest in the class
- Plickers and TPS activity are fine and interesting
- Methods of adopting teaching and learning practices
- Some more pedagogical methods need to be discussed / trained
- More active learning strategies such as collaborative learning
- About the open source software
- One minute exam/assessment

Future Plan of Action

The IQAC work out strategies for continuous improvement and necessary measures and efforts are taken periodically to reach academic excellence. Additionally IQAC holds the responsibility of organizing seminars and workshops on quality sustenance and quality enhancement in the Higher Education Institutions. To maintain the quality standards, continuously strengthening in all aspects of quality parameters set by NAAC & NBA.

- Implementation of Outcome Based Education in the departments with true spirit.
- Implementing blooms level Question paper in internal assessment.
- Implementing some of the best practices in teaching & learning.
- Effective class room teaching using modern online tools. Planning to use of effective techniques to keep students engaged.

Conducting SWOT analysis every academic year, based on that action plan would be prepared for further enhancing the quality.

NAAC Sponsored two days National Seminar on Quality Improvement in Technical Education through Outcome Based Education on 14th -15th December 2018

Inaugurating Seminar by lighting lamp

Standing ovation for prayer song

Dr. B. Kanmani delivering her lecture

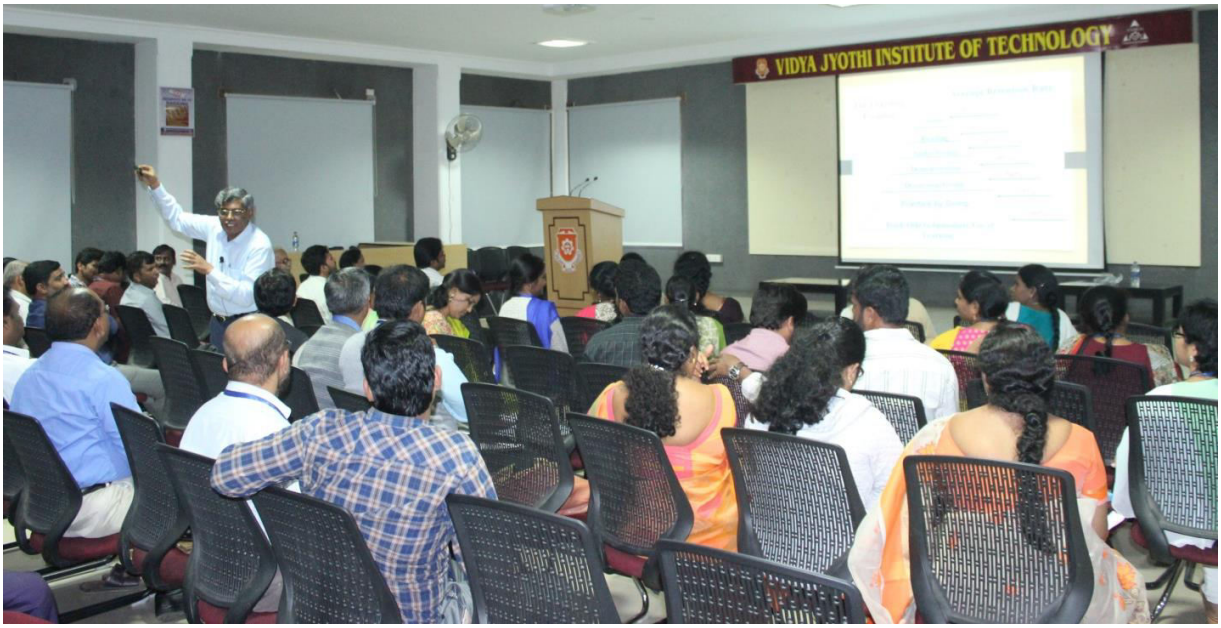
Group Photo with the resource person Dr. B. Kanmani

Dr. Madhuri Mavinkurve delivering her lecture

Group Photo with the resource person Dr. Madhuri Mavinkurve

Dr Ranjith Ramdurai delivering his lecture

Group Photo with the resource person Dr Ranjith Ramdurai



Dr. B. V. Appa Rao delivering his lecture

Dr. B. V. Appa Rao delivering his lecture

NAAC Sponsored two days National Seminar on Quality Improvement in Technical Education through Outcome Based Education on 14th -15th December 2018

Experience of participants during 2 days seminar

Certificate Distribution on Valedictory Function

Group Photo with the resource person Dr. B. V. Appa Rao