

Innovations in Academics

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Perceived Role of Higher Education

Convey knowledge

Create knowledge

Create and develop ideas

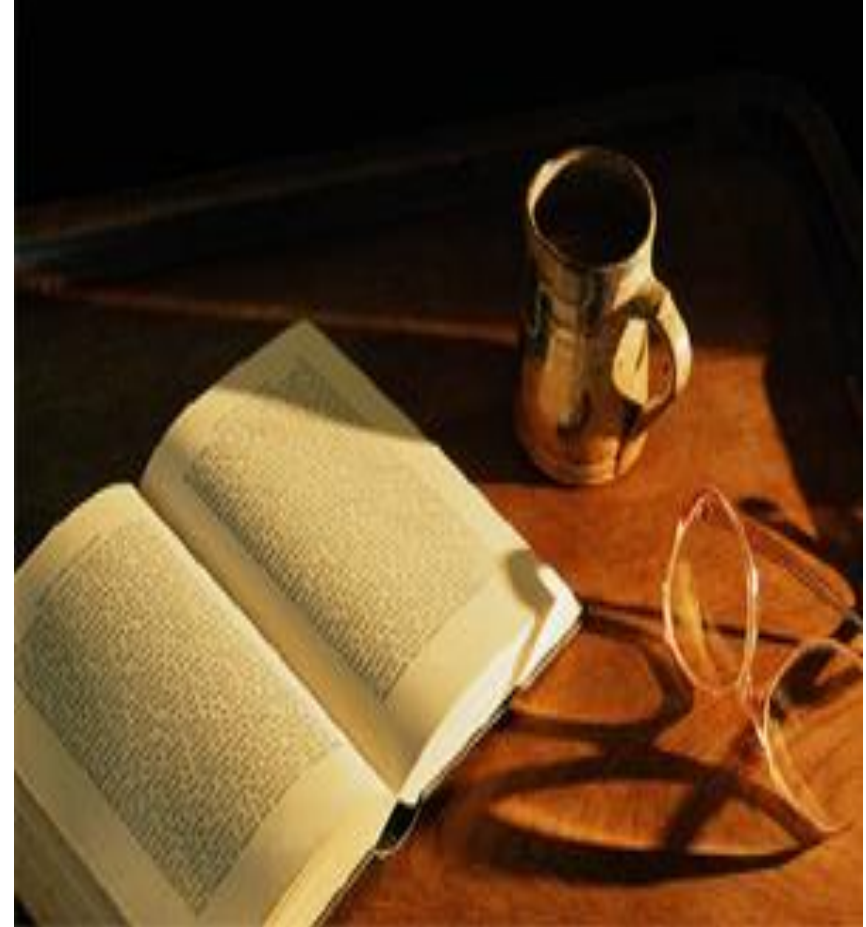
Innovations

Publish

Develop future citizens

Create a better society

...



Changing Times . . .

Present system has worked for a long time

A lot of education involved imparting information

- But today that does not work with lot of online information / explanation that is available (internet has been a game changer)

Role of educator is changing

- **mentors, advisors, ...**
- **No longer teachers**

Need for new academic structure



AN AVALANCHE IS COMING, Higher Education and the Revolution Ahead by Michael Barber, Katelyn Donnelly, Saad Rizvi, March 2013

1. *Does the curriculum need complete overhaul?*
2. *What are the right models of learning, now that the traditional lectures are becoming less effective*
3. *Which students should be targeted?*
4. *Just as we've seen the forces of technology and globalization transform sectors such as media and communications or banking and finance over the last two decades, these forces may now transform higher education*
5. *The traditional university is being unbundled*



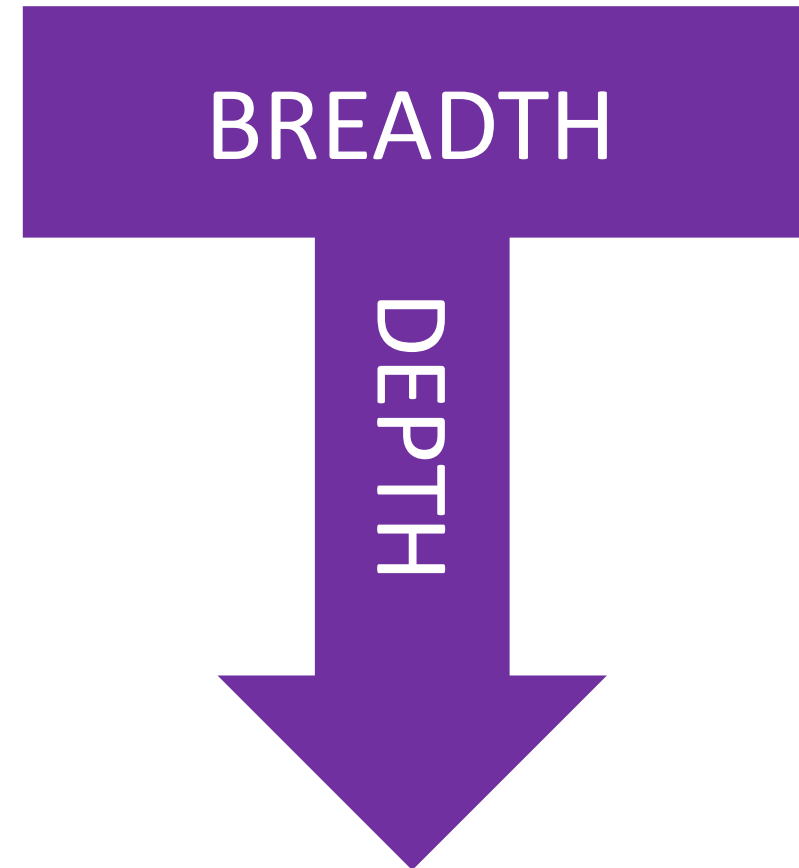
Some More Questions (IIT Hyderabad) ...

1. Why lack of motivations among students?
2. Why low attendance?
3. Why uneven student interest?
4. How to bridge the gulf between theory and practice?
5. How to bridge the gulf between breadth and depth?
6. What is the relevance of non-core subjects?
7. How to have a flexible curriculum?
8. How to space the curriculum based on individual potential?
9. How to make the curriculum interdisciplinary?
10. How to increase industry interactions?
11. How to incorporate research in under graduate curriculum?
12. *Has the 3 credit hour system outlived its utility?*



Philosophy: *The new program should capture ...*

1. T-Education
 - *Breadth with Depth*
2. Flexibility
3. Foster Interdisciplinary education
4. Wider choice of electives
5. Very early exposure to new science and technology development
6. Foster Research at undergraduate level
7. Synergy in projects – hopefully leading to products
8. Students can pace their program
9. Student to design their program
10. Encourage creativity



Some Innovations in Academics at IIT Hyderabad

1. Fractal Academics Implemented at IITH
 - a) Innovative and first of its kind academic program (<https://www.iith.ac.in/fractal/frac.html>)
2. Digital Fabrication Lab (3D-Printing) for first semester students – first of its kind in academia
3. AI and Humanity – Minor
4. Minor in Entrepreneurship for all students. All the modules taught by VCs, Entrepreneurs, Business Professionals only. Once again first of its kind
5. Double Major: A student can get B.Tech. in two disciplines in 4 to 5 years
6. Minors and Honors
7. 5 year Dual degree possibility after two years if the candidate desires to pursue B.Tech. + M.Tech.
8. Student can take a year off to pursue whatever his heart desires

Some Innovations in Academics ...

8. Engineering Science

1. Selection of a branch after 4 semesters of Engrg Science
2. Possibility of B.Tech. in the area chosen after 4 semester in the Engrg. Science Stream
3. Possibility of doing a full Engineering Science BTech

9. Creative Arts Series (e.g. fractal courses taught by professionals in art and design -- like Theater, Music, Movie Making, Madhubani Painting, Kalamkari Painting, Dance, etc.)



**Actively moving towards project based learning
rather than only lecture based learning**

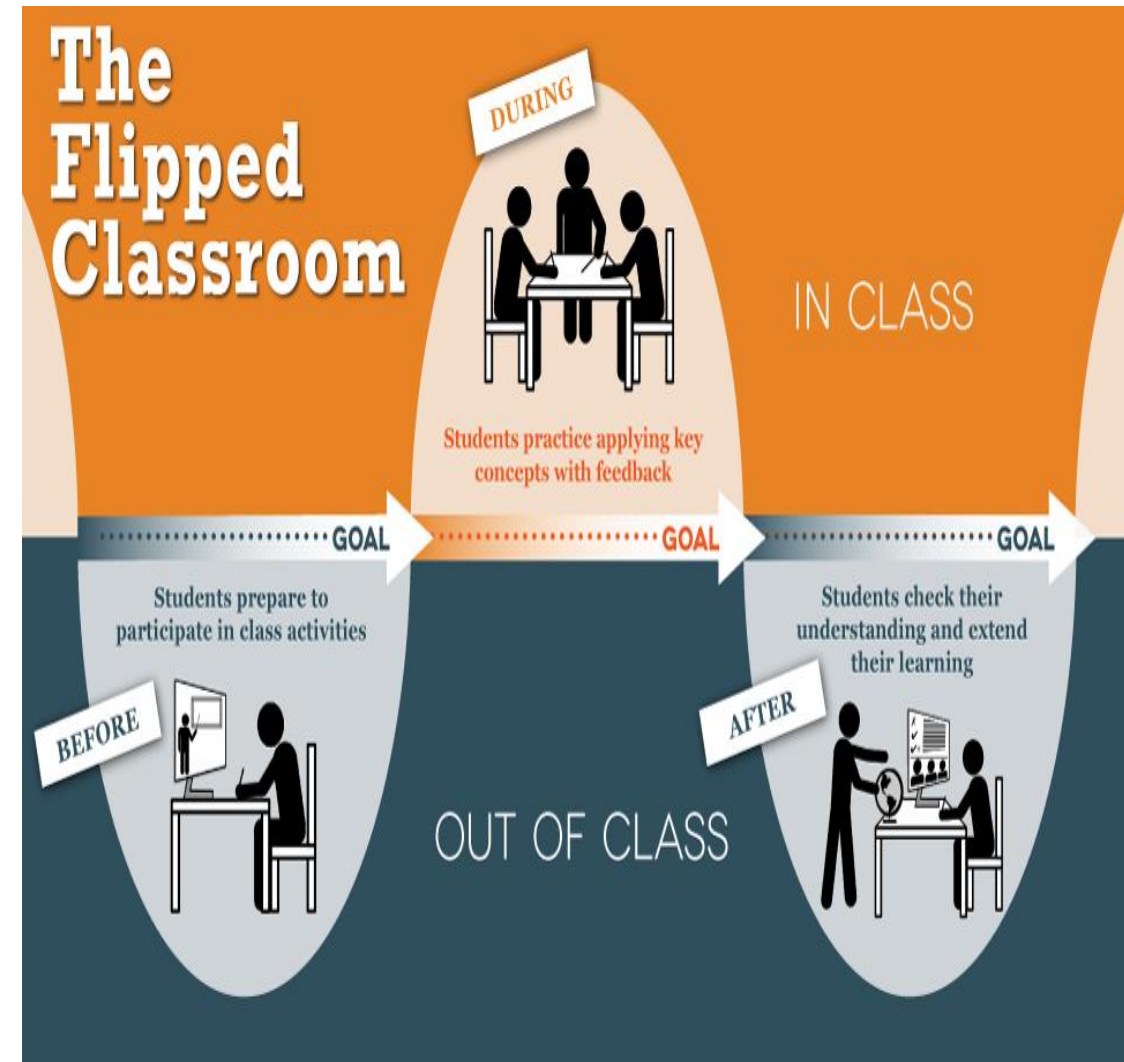
Some Innovations in Academics ...

- 9. All Course Option M.Tech.
- 10. [M.Tech. in AI and ML](#)
- 11. An M.Tech. Program in Data Sciences for working professionals only; first of its kind in India
(<https://cse.iith.ac.in/?q=node/136>)
- 12. B.Tech. in AI
- 13. M.Tech. in Climate Change
- 14. Collaborative class room



Exploiting Digital Medium and Leveraging ICT

- Flip Teaching
 - Video and digital material made available ahead of time
 - Classroom becomes collaborative event
 - Students learn thru discussions and projects
 - Teacher becomes a mentor



Digital Medium ...

- In future, use of
 - **Augmented Reality**
 - **Virtual Reality**
- Students will have a look and feel of the subject
- Teach latest things in the first year first semester
 - **Like IoT**
 - **3D printing**
 - **Drones**
 - **Gen editing**
 - **etc**

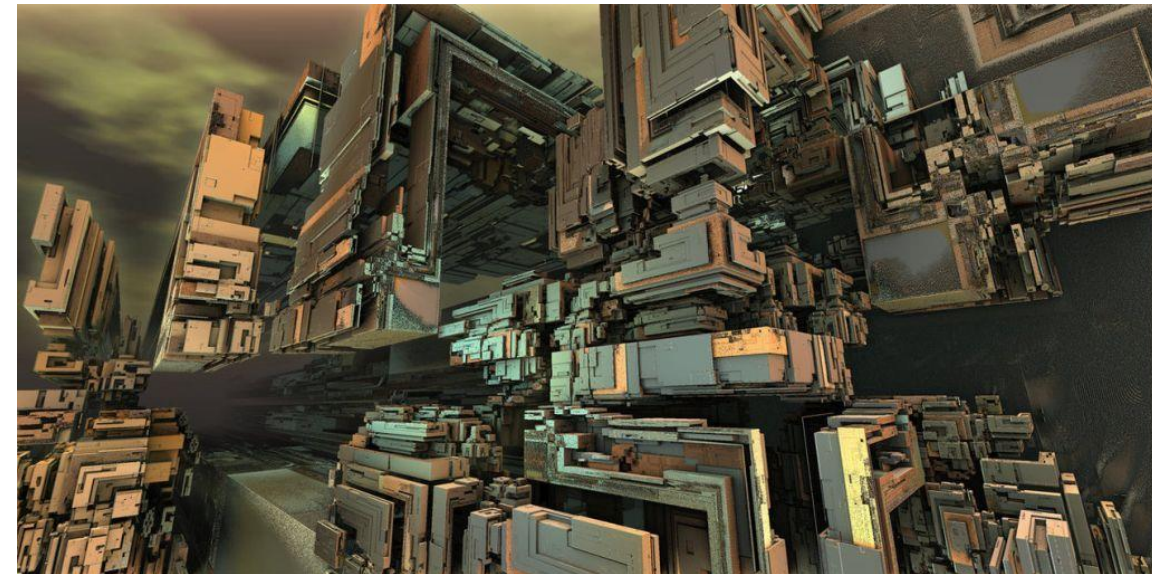
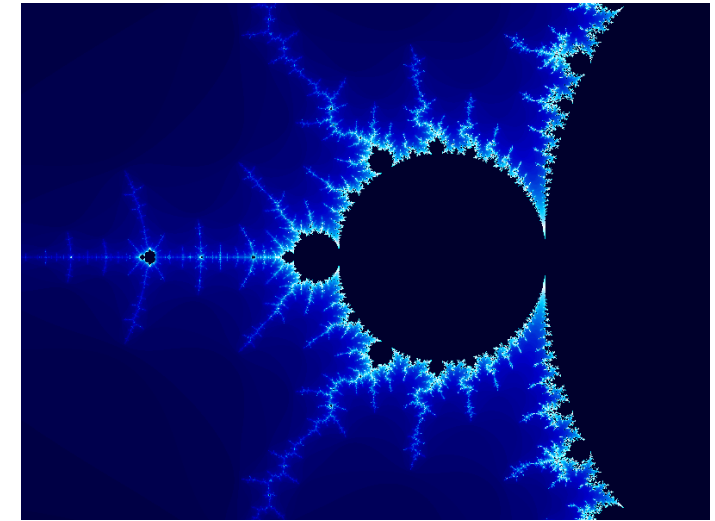
<https://www.youtube.com/watch?v=3qpgMLzBi30>



FRACTAL ACADEMICS

Fractal Academic Program

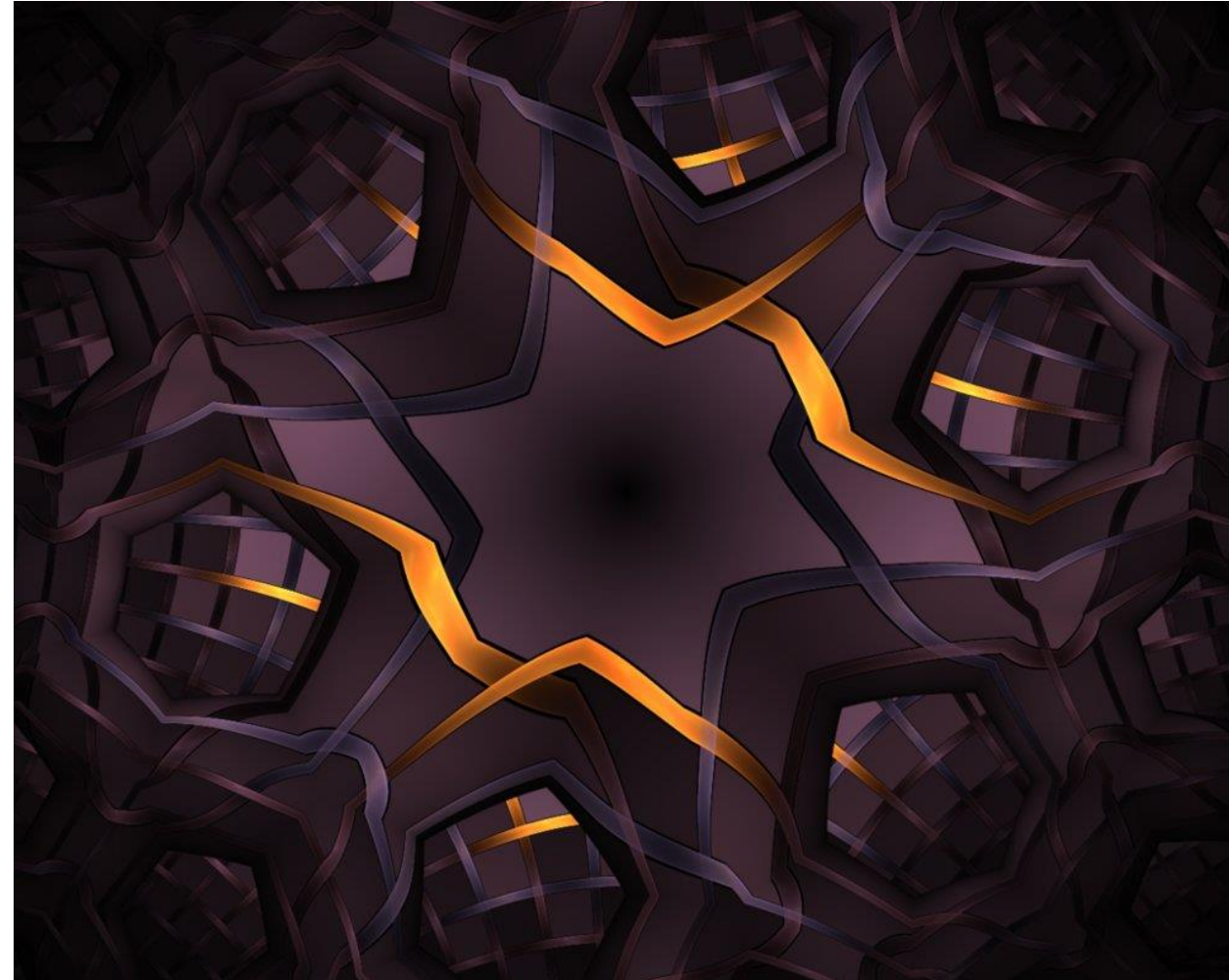
1. A novel academic program launched at IITH – we believe it is first of its kind
2. Courses of mainly **1 or 2 credits**
3. Many Departmental courses in the very first year
4. Generate excitement among the students in the very first year
5. Facilitate interdisciplinary learning
 - a. For example, civil, mechanical, chemical engineers, etc taking 1 credit signal processing course offered by electrical engineering



Basic Building Blocks

Atomize the courses and programs

- I. 1 credit courses for breadth***
 - Core courses
- II. 1.5, 2, 2.5 credit courses for depth***
 - Specialized courses
 - Electives
 - Projects and building prototypes / products
 - Bridging gulf between theory and practice



One Credit Courses ...

- All core courses
- Helps interdisciplinary education
- Open to all students – allows for greater breadth
- Students have the option of greater number of interesting courses
- Allows students to better tailor their coursework and choose across Departments
- Large basket of non-technical courses (LA – Liberal Arts + CA-Creative Arts)
- Better access to a wide variety of courses increases exposure and preparedness for research
- Synergy in projects - foundation for product development



One Credit Courses ...

- A balance is sought between technical and non-technical courses to reduce stress when students enter IIT Hyderabad
- The first two semesters expose students to all the basic tools required for the rest of their Bachelors program
- *The last two years have only electives*



Illustrative Fractal Curriculum For Electrical Engineering



Semester 1 Courses (Credits) Total Credits: 15	Duration					
	1/6	2/6	3/6	4/6	5/6	6/6
1. Independent Project (1)						
2. Digital Fabrication (2)						
3. Calculus – I (1)						
4. Calculus – II (2)						
5. Classical Physics (1)						
6. Electric Circuits (1)						
7. Magnetic Circuits (1)						
8. Digital Logic Design (1)						
9. Digital System Design (1)						
10. Signals and Communications (1)						
11. Internet of Things (1)						
12. Bioengineering (1)						
13. Liberal Arts/Creative Arts Elective (1)						

A *sample* list of Creative Arts Courses in Fractal Academic Program

Creative Arts option open to all students of IIT Hyderabad







Course number	Course Title	Name of instructor	Dates	Credits	Max intake
CA 1010	Introduction to Theatre	MK Raina	TBA	1	80
CA 1014	Exploring the Performance Spectrum	Jayachandran Palazhy	TBA	1	100
CA 1020	Introduction to Pottery and Ceramics	Jagruti Dutta	10-14 Feb	1	80
CA 1021	Understanding Cinema: Five Days at the Movies	Shubhra Gupta	TBA	1	100
CA 1023	Introduction to Karnatic Music	Vasudev	TBA	1	100
CA 1025	Madhubani Painting	Shalinee Kumari	TBA	1	50
CA 1027	Understanding Hyderabad and Its Heritage	Various Faculty	TBA	1	40
CA 1032	Musics from the World	Arko Mukhaerjee	27-30 Jan	1	50
CA 1033	Filmmaking for Beginners	Rajeev Ravi	TBA	1	80













Semester 2 Courses (Credits) Total Credits: 15	Duration					
	1/6	2/6	3/6	4/6	5/6	6/6
1. Independent Project (1)						
2. Vector Calculus (1)						
3. Differential Equations (1)						
4. Analog Electronics (1)						
5. Matrix Analysis (1)						
6. Data Analytics (2)						
7. Basic Control Theory (1)						
8. Digital Signal Processing (1)						
9. Data Structures (2)						
10. Semiconductor Fundamentals (1)						
11. Embedded Programming (1)						
12. Physiology for Engineers (1)						
13. Liberal Arts/Creative Arts Elective (1)						













Semester 3 Courses (Credits) Total Credits: 16	Duration					
	1/6	2/6	3/6	4/6	5/6	6/6
1. EE Independent Project (1)						
2. Science Elective (1)						
3. Environmental Chemistry (1)						
4. Chemistry Lab (2)						
5. Microprocessors (1)						
6. Device Physics (2)						
7. Transformers and DC Machines (2)						
8. AC Machines (1)						
9. Power Electronics (1)						
10. Random Processes (1)						
11. Digital Modulation Techniques (1)						
12. Liberal Arts/Creative Arts Elective (1)						

Semester 4 Courses (Credits) Total Credits: 16	Duration					
	1/6	2/6	3/6	4/6	5/6	6/6
1. EE Independent Project (1)						
2. Complex Variables (1)						
3. EM and Maxwell’s Equations (1)						
4. Digital Electronics (1)						
5. Mixed Signal Electronics (1)						
6. Embedded Systems (1)						
7. CMOS Fabrication (1)						
8. Control Systems (2)						
9. Renewable Energy & Power Systems (1)						
10. Electrical Machines Lab (2)						
11. Antenna Design (1)						
12. Information Science (1)						
13. Liberal Arts/Create Arts Elective (2)						

Semester 5 Courses (Credits) Total Credits: 16	Duration					
	1/6	2/6	3/6	4/6	5/6	6/6
1. EE Independent Project (1)						
2. Science Elective (2)						
3. Smart Grid (1)						
4. Power Systems Practice (2)						
5. Advanced DSP (2)						
6. Core Elective (3) (1+1+1 or 2+1)						
7. Free Elective (3) (1+1+1 or 2+1)						
8. Liberal Arts/Creative Arts Elective (2) (1+1)						









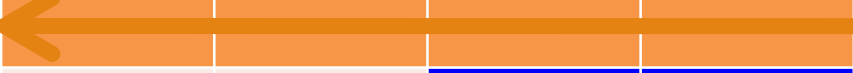









Semester 6 Courses (Credits) Total Credits: 17	Duration					
	1/6	2/6	3/6	4/6	5/6	6/6
1. EE Independent Project (1)						
2. Science Elective (1)						
3. Engineering Elective (2)						
4. Core Elective (9) (different combination)						
5. Free Elective (3) (1+1+1 or 2+1)						
6. Liberal Arts/Creative Arts Elective (1)						





















Semester 7 Courses (Credits) Total Credits: 15	Duration					
	1/6	2/6	3/6	4/6	5/6	6/6
1. EE Independent Project (3)						
2. Science Elective (1)						
3. Core Elective (3) (1+1+1 or 2+1)						
4. Free Elective (6) (2+2+2 or any other combination)						
5. Liberal Arts Elective (1)						
6. Creative Arts Elective (1)						



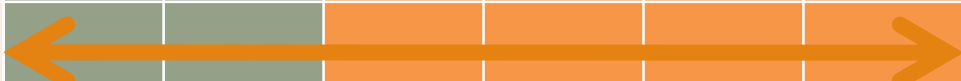



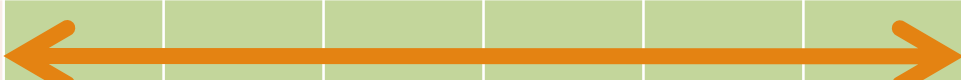


Semester 8 Courses (Credits) Total Credits: 15	Duration					
	1/6	2/6	3/6	4/6	5/6	6/6
1. EE Independent Project (3)						
2. Science Elective (1)						
3. Core Elective (3) (1+1+1 or 2+1)						
4. Free Elective (6) (2+2+2 or any other combination)						
5. Liberal Arts Elective (1)						
6. Creative Arts Elective (1)						

Illustrative Fractal Curriculum For Computer Science and Engineering







Semester 1 Courses (Credits) Total Credits: 15	Duration					
	1/6	2/6	3/6	4/6	5/6	6/6
Independent Project (1)						
Calculus-I (1)						
Calculus-II (2)						
PH Electives (1)						
CY Electives (1)						
Digital Fabrication (2)						
Introduction to Programming (2)						
Liberal & Creative Arts Electives (1)						
Discrete Structures I (2)						
Digital Logic Design (1)						
Digital System Design (1)						




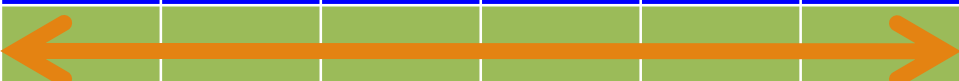
Semester 2 Courses (Credits) Total Credits: 15	Duration					
	1/6	2/6	3/6	4/6	5/6	6/6
Vector Calculus (1)						
Linear Algebra (1)						
PH Electives (2)						
CY Electives (1)						
BO Electives (1)						
Introduction to Data Structures (3)						
Discrete Structures II (2)						
Liberal & Creative Arts Electives (2)						
Free Electives (1)						
DSP (1)						





Semester 3 Courses (Credits) Total Credits: 15	Duration					
	1/6	2/6	3/6	4/6	5/6	6/6
Probability (1)						
PH electives (1)						
Physics Lab (2)						
Data Structures (3)						
Principles of Programming Languages I (1)						
Liberal & Creative Arts Electives (2)						
Free Electives (2)						
OS I (1)						
Computer Architecture (2)						

Semester 4 Courses (Credits) Total Credits: 16	Duration					
	1/6	2/6	3/6	4/6	5/6	6/6
Theory of Computation (2)						
Introduction to Complexity Theory (1)						
Principles of Programming Languages II (3)						
Free Electives (2)						
MA Elective (1)						
Compilers-I (1)						
Algorithms (3)						
OS II (3)						

Semester 5 Courses (Credits) Total Credits: 16	Duration					
	1/6	2/6	3/6	4/6	5/6	6/6
BM Electives (1)					←→	→
Compilers-II (3)	←→			→		
Computer Networks I (1)	←→					
Free Electives (5) (1, 2 or 3 credits)	←→					→
DBMS I (1)					←→	→
Department Electives (5) (1, 2 or 3 credits)	←→					→

Semester 6 Courses (Credits) Total Credits: 15	Duration					
	1/6	2/6	3/6	4/6	5/6	6/6
Computer Networks II (3)						
DBMS II (3)						
Free Electives (3) (1, 2 or 3 credits)						
Department Electives (6) (1, 2 or 3 credits)						

Semester 7 Courses (Credits) Total Credits: 18	Duration					
	1/6	2/6	3/6	4/6	5/6	6/6
Software Engineering (3)						
Free Electives (3) (1, 2 or 3 credits)						
Department Electives (9) (1, 2 or 3 credits)						
Liberal Arts and Creative Arts Electives (3)						

Semester 8 Courses (Credits) Total Credits: 15	Duration					
	1/6	2/6	3/6	4/6	5/6	6/6
Professional Ethics (1)						
Free Electives (6) (1, 2 or 3 credits)						
Department Electives (6) (1, 2 or 3 credits)						
Liberal Arts and Creative Arts Electives (2)						

Science	17
LA/CA	11
Department Core	44
Department Electives	26
ID courses	5
Free electives	22
Total	125

Strength and Challenges of Fractal Academics

<i>Strengths</i>	<i>Challenges</i>
Foster Creativity	
Better exposure to larger number of topics	
More flexibility in breadth and depth	Fractal Thinking!
Foster Interdisciplinary education and undergraduate research	Context switching !
Easier implementation of fast and slow track program	Evaluation!
All round development - Holistic education	

Future Education System

- **Dynamism:**
 - making the education system agile so that it quickly responds to changes in science, technology and aspirations of the youth
- **Modularity:**
 - Future education will have to be modular in nature – length, breadth and the depth of the module will be variable and will depend on the subject

Future Education System ...



Credit and Mobility System:

Modularity, and flexibility will also enable mobility and credit transfer. Fundamentally, education will be based on clearing credits. On accumulating a certain number of specified credits, one will get the degree. Moreover, one can move from one place to another and carry forward the cleared (accumulated credits) – almost like bank accounts



Nonlinearity, Flexibility and Self-Paced:

a student can choose his/her path to education



Design Spine:

creative design is becoming as important as engineering. With advent of new technologies, like digital fabrication and interactive graphics, the divide between creative design and engineering design is being bridged. Product development is not only about engineering and technology but is also about creative design

Future Education System ...

- **Experiential Learning:**
 - The future requires experiential learning which has several components:
 - teaching and learning will involve lot more project work – in fact, here too the projects will be chosen by students – they will not be assigned.
 - Classes will involve group discussions, problem posing, problem solving, posing challenges and possibly tackling challenges.
 - Teacher will not be a teacher but will be a mentor, a guide, an advisor, a moderator, a bouncing board for ideas
 - ...

Concluding Remarks



Flexibility a must



Fractal Academics has been a success



Fractal Academics is implemented at IIT Bhila also and has been received very enthusiastically by IIT Bhilai students.



Experiential learning



Objective is to get excitement early in the academic program rather than in the final year



Need to bring fun back into education



Need to think creatively and out of the box



President Ram Nath Kovind receiving the memento from IIT-H Director Prof UB Desai during the Seventh Education Ceremony in Sangareddy district on Sunday.

Do not confine your children to your own learning, for they were born in another time (unknown)

Many Thanks