भारतीय प्रौद्योगिकी संस्थान हैदराबाद
Indian Institute of Technology Hyderabad

Course booklet for the batch 2014-15

Introduction

भारतीय प्रौद्योगिकी संस्थान हैदराबाद
Indian Institute of Technology Hyderabad

Fractal Academics

Special thanks and gratefully acknowledge Prof. Raj Reddy of CMU for providing the core idea of fractional credit courses

Perceived Role of Higher Education

- Convey knowledge
- Create knowledge
- Create and develop ideas
- Innovations
- Publish
- Develop future citizens
- Create a better society
- …

Gradient

- Societal Gradient
- Rate of change in Society was very slow from 50s to 90s
- Since 90s, and in particular since 95 the rate of change has been phenomenal
- Gradient in Teaching Methods since 50s
- Very small
- Sure we use ppts and latest tech-gizmos, but that is not real change
- Complete mismatch between the two rates!

Changing Times

An Avalanche Is Coming, Higher Education and the Revolution Ahead by Michael Barber, Katelyn Donnelly, Saad Rizvi, March 2013

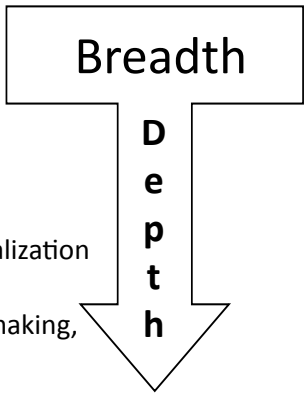
1. Does the curriculum need complete overhaul?
2. What are the right models of teaching and learning now that the traditional lectures are becoming less effective
3. Which students should be targeted?
4. Just as we've seen the forces of technology and globalization transform sectors such as media and 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…

- T-Education
- Breadth with Depth
- Flexibility
- Foster Interdisciplinarity
- Wider choice of electives
- Foster Research at undergraduate level
- Synergy in projects – hopefully leading to products
- Students can pace their program
- Greater choice for knowledge acquisition and specialization
- Encourage creativity
- Bouquet of courses in Creative Arts (Music, Movie making,
- fine arts, photo journalism, performing arts, etc.)
- Facilitate industry interactions



Initial Attempts: Fractional Credit Courses

- A typical 3 lecture course has 3 credits leading to 42 lecture hours in a semester.
- Fractional credits can be 0.5, 1, 1.5, 2.0, 2.5, 3.0 having 7, 14, 21, 28, 35 and 42 lectures hours respectively.
- Some examples of fractional credit courses (1 credit) that were offered at IITH:
  - Trends in Storage Systems (by NetApp)
  - Mobile Applications (by Adobe)
  - Data Management and Computing on the Cloud
  - Empowering Three Billion (taught by former President Dr. Kalam)
  - Finance and Economy
  - Sales and Marketing
  - Photo Journalism
  - Movie Making
  - Drama (Performing Arts)
  - Courses by Visiting Faculty in Math and EE from USA
  - Course in Material Science by visiting faculty from France
  - …

Minor in Entrepreneurship – Unique Program at IITH

S.No.	Course Name	Credits	Instructor	Semester
Semester 3.1				
1	Introduction to Finance and Economy	1	Sri Nagesh	3rd Year, 1st Semester
2	Introduction to Sales and Marketing	1	J. P. Sahu	3rd Year, 1st Semester
3	Introduction to Entrepreneurship	1	Ajai Chowdhry	3rd Year, 1st Semester
Semester 3.2				
4	Strategic Innovative Entrepreneurship	1	Ramesh Loganathan	3rd Year, 2nd Semester
5	Introduction to Business plan	1	Satish Andra / Srini Adepallli	3rd Year, 2nd Semester
6	Early Customer Acquisition and Relationship Management	1	Santanu Paul	3rd Year, 2nd Semester
Semester 4.1				
7	Business Plan Development (Project)	3	Murali Bukkapatnam and IITH Faculty	4th Year, 1st Semester
Semester 4.2				
8	HR and Leadership	1	B. V. R. Mohan Reddy	4th Year, 2nd Semester
9	Company Valuation	1	Hemant Kanakia	4th Year, 2nd Semester
10	Risk Management	1	Pradeep Mittal	4th Year, 2nd Semester
Total Credits		12		

Fractal Academic Program: Novel Program Launched at IITH

- In Aug 2013 launched in Electrical Engineering
- Aug. 2014 for all B.Tech. Programs
- Aug 2014, some M.Tech. Programs (Integrated Design and Manufacturing)
- **Courses of 0.5, 1, 1.5, 2, 2.5 etc. credits**
- Departmental courses in the very first year
- Inherently Multidisciplinary
- Promotes R and D from an early stage
- Courses in Liberal Arts
- Courses in Creative Arts
  - Incorporates the Design Spine
- Holistic Education

Basic Building Blocks

- Atomize the courses and programs
  - 1 credit courses for breadth
- Core courses
- 1.5, 2, 2.5 credit courses for depth
  - Specialized courses
  - Electives
  - Projects and building prototypes / products
  - Bridging gulf between theory and practice

1 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
- 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 curriculum potentially makes students ready for internship right after the first year*

Outside Specialization Courses (Partial List)

- Photography
- Entrepreneurship
- Movie making
- Western classical music
- Drama
- Life science concepts
- Music and mathematics
- Space program
- Efficiency vs goodness
- Healthcare and technology
- Teamwork and collaboration
- …
- Managing failure
- Deconstructing design
- Hindustani classical music
- Fine arts
- Basics of vision
- History of math
- History of science
- Carnatic classical music
- Linguistic abilities
- Personal Effectiveness
- Science, Society and Culture
- …

Science and Technology Breadth Courses (Partial List)

- Genomics
- Brain and cognition
- Big data
- Logic
- Philosophy
- Molecular Communication
- Drug delivery
- Energy Storage Technologies
- …
- Future Cities
- Singularities in Science and Technologies
- Semantic Web
- Future Materials
- Water
- Engineering in Biology
- …

Illustrative Fractal Program in Electrical Engineering at IITH

Semester 1 Courses (Credits) Total Credits: 18	Duration 1/6	2/6	3/6	4/6	5/6	6/6
1. Independent Project (1)	←	—	—	—	—	→
2. Digital Fabrication (2)	←	—	—	—	—	→
3. Introduction to Programming (1)	←	—	—	—	—	→
4. Introduction to Programming Lab (2)	←	—	—	—	—	→
5. Calculus – I (1)	←	—	→			
6. Calculus – II (2)			←	—	—	→
7. Classical Physics (1)			←	—	→	
8. Boolean Algebra (1)	←	—	→			
9. Electric Circuits (1)			←	—	→	
10. Magnetic Circuits (1)					←	→
11. Signals and Communications (1)					←	→
12. Bioengineering (1)			←	—	→	
13. Liberal Arts Elective (1)	←	—	→			
14. Creative Arts Elective (1)			←	—	→	
15. Free Elective 1 (1)					←	→

Each Semester Partitioned into 6 Segments each representing 0.5 credit

Semester 2 Courses (Credits) Total Credits: 19	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. EM and Maxwell's Equations (1)			←	→		
5. Introduction to Data Structures (1)	←	—	—	→		
6. Introduction to Data Structures Lab (2)	←	—	—	→		
7. Matrix Analysis (2)	←	—	—	—	—	→
8. Data Analytics (2)			←	—	—	→
9. Basic Control Theory (1)	←	→				
10. Digital Signal Processing (1)			←	→		
11. Semiconductor Fundamentals (1)					←	→
12. Embedded Programming (1)					←	→
13. Physiology for Engineers (1)	←	→				
14. Liberal Arts Elective (1)	←	→				
15. Creative Arts Elective (1)			←	→		
16. Free Elective 1 (1)					←	→

Semester 3 Courses (Credits) Total Credits: 20	Duration					
	1/6	2/6	3/6	4/6	5/6	6/6
1. EE Independent Project/Free Elective (1)	←	—	—	—	—	→
2. Computer Organization (1)					←	→
3. Science Elective (1)			←	→		
4. Environmental Chemistry – I (1)	←	→				
5. Chemistry Lab (2)	←	—	—	—	—	→
6. Device Physics (2)	←	—	—	→		
7. Linear Electronics (1)			←	→		
8. Digital Systems and Design (1)			←	—	—	→
9. Digital Modulation Techniques (1)	←	→				
10. Information Science (1)	←	→				
11. Advanced DSP (2)			←	—	—	→
12. Transformers and DC Machines (2)			←	—	—	→
13. Graph Theory (1)	←	→				
14. Antenna Design (1)			←	→		
15. Liberal Arts Elective (1)	←	→				
16. Creative Arts Elective (1)			←	→		
17. Free Elective 1 (1)					←	→

Semester 4 Courses (Credits) Total Credits: 20	Duration					
	1/6	2/6	3/6	4/6	5/6	6/6
1. EE Independent Project (1)	←	—	—	—	—	→
2. Complex Variables (1)			←	→		
3. Science Elective (1)					←	→
4. Renewable Energy and Power Systems (1)	←	→				
5. Smart Grid (1)			←	→		
6. Optimization (1)			←	—	—	→
7. AC Machines (1)					←	→
8. Power Electronics (1)			←	→		
9. Introduction to Multimedia (1)	←	→				
10. Channel Coding (1)					←	→
11. Advanced Analog Electronics (2)	←	—	—	→		
12. Embedded Systems (1)					←	→
13. CMOS Fabrication (1)			←	→		
14. Control Systems (1)	←	→				
15. Computer Networks (1)					←	→
16. Thin Films and Devices (1)	←	→				
17. Liberal Arts Elective (1)	←	→				
18. Creative Arts Elective (1)			←	→		
19. Free Elective 4 (1)					←	→

Semester 5 Courses (Credits) Total Credits: 19	Duration					
	1/6	2/6	3/6	4/6	5/6	6/6
1. EE Independent Project (1)	←	—	—	—	—	→
2. Science Elective (2)	←	—	—	→		
3. Engineering Elective (2)			←	—	—	→
4. Random Processes (2)	←	—	—	→		
5. Power Electronics Analysis and Design (1)	←	→				
6. Digital Chip Design (2)			←	—	—	→
7. Core Elective 1 (2)	←	—	—	→		
8. Core Elective 5 (2)			←	—	—	→
9. Electrical Machines Lab (2)	←	—	—	—	—	→
10. Liberal Arts Elective (1)	←	→				
11. Creative Arts Elective (1)			←	→		
12. Free Elective 5 (1)					←	→

Semester 6 Courses (Credits) Total Credits: 19	Duration					
	1/6	2/6	3/6	4/6	5/6	6/6
1. EE Independent Project (1)	←	—	—	—	—	→
2. Science Elective (2)	←	—	—	—	→	
3. Engineering Elective (2)			←	—	—	→
4. Power Systems Practice (2)			←	—	—	→
5. Cellular Networks (1)	←	→				
6. Core Elective 3 (2)	←	—	—	→		
7. Core Elective 4 (2)			←	—	—	→
8. Core Elective 5 (2)	←	—	—	→		
9. VLSI Lab (2)	←	—	—	—	—	→
10. Liberal Arts Elective (1)	←	→				
11. Creative Arts Elective (1)			←	→		
12. Free Elective 6 (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. Core Elective 6 (2)	←	—	—	→		
3. Core Elective 7 (2)			←	—	—	→
4. Core Elective 8 (2)	←	—	—	→		
5. Liberal Arts Elective (1)	←	→				
6. Creative Arts Elective (1)			←	→		
7. Free Elective 7 (2)	←	—	—	→		
16. Free Elective 8 (2)			←	—	—	→

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. Core Elective 9 (2)	←	—	—	→		
3. Core Elective 10 (2)			←	—	—	→
4. Core Elective 11 (2)	←	—	—	→		
5. Liberal Arts Elective (1)	←	→				
6. Creative Arts Elective (1)			←	→		
7. Free Elective 9 (2)	←	—	—	→		
16. Free Elective 10 (2)			←	—	—	→

Fractal Program in M.Tech. Integrated Design and Manufacturing

SEMESTER – I	
Course Name	Credits
Mathematical Methods for Engineers	3
Elasticity and Plasticity	1.5
Fluid Mechanics and Heat Transfer	1.5
Computational Fluid Dynamics (CFD) Tools (Theory + Lab)	1.5
Finite Element Methods: Theory	3
Finite Element Methods: Lab	1
Material Science and Material Selection	1.5
Manufacturing Processes	2
Design for Manufacturability and Assembly	1
Scaling Laws and Multi-scale Manufacture	1
Total	**17**

SEMESTER – II	
Course Name	Credits
Mathematical Elements for Geometrical Modeling	1.5
Computer Integrated Manufacturing	1.5
Process Control and Optimization	1.5
Artificial Intelligence	1.5
Choose one from: (1) Material Removal Processes (2) Material Joining Processes (3) Material Forming Processes	3
Integrated Design and Manufacturing Lab	2
Core Electives	3
Free Electives	1
Total	**15**

SEMESTER – III		
	Course Name	Credits
ME6106	Seminar Course	1
ME6005	Thesis (Stage1)	14
	Total	**17**

SEMESTER – IV		
	Course Name	Credits
ME6106	Seminar Course	1
ME6005	Thesis (Stage1)	14
	Total	**17**

Total Number of Credits: 62

List of Core Electives for Integrated Design and Manufacturing	
Course Name	Credits
Automation and Robotics	1
Management of Manufacturing Systems	1
Additive Manufacturing	1
Micro-Manufacturing	1
Measurement Science and Techniques	1
Plastic Part Manufacture and Design	1
Reliability and Fault Diagnostics	1
Fatigue, Fracture and Life Cycle Estimation	2
Precision Machine Design*	2
Phase Change Phenomenon*	1

Strength and Challenges of Fractal Academics

Strengths	Challenges
Foster Creativity	
Better exposure to larger number of topics	
More flexibility in breadth and depth	Perhaps spreading too thin / losing focus?
Foster Interdisciplinary education and undergraduate research	Context switching / distracting?
Easier implementation of fast and slow track program	
All round development - Holistic education	

Concluding Remarks

- Trying something innovative is imperative -- of course it will involve some calculated risks
- The fractal academic program is innovative and evolutionary
- Strong belief that Fractal Academics will inculcate the spirit of innovation and fetch desired results
- We believe atomization of the academic program a must

1.1. Departments

The Institute is organised into the following departments:

- Department of Biomedical Engineering
- Department of Biotechnology
- Department of Chemical Engineering
- Department of Chemistry
- Department of Civil Engineering
- Department of Computer Science and Engineering
- Department of Design
- Department of Electrical Engineering
- Department of Engineering Science
- Department of Liberal Arts
- Department of Materials Science and Metallurgical Engineering
- Department of Mathematics
- Department of Mechanical and Aerospace Engineering
- Department of Physics

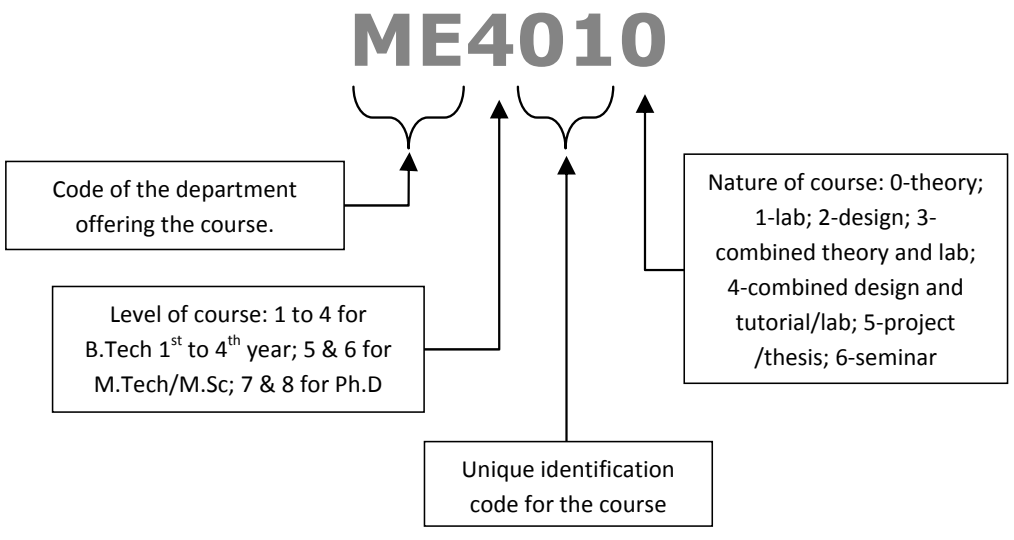
1.2. Academic Programs

The Institute is running the following Degree Programs based on Fractal Academic System:

- **B.Tech. Programs (4 Year, Fractal Academic Program)**
  - Civil Engineering
  - Chemical Engineering
  - Computer Science and Engineering
  - Electrical Engineering
  - Engineering Physics
  - Engineering Science
  - Materials Science and Metallurgical Engineering
  - Mechanical Engineering
- **M.Tech. Programs (2 Year, Fractal Academic Program)**
  – Chemical Engineering
  - Mechanical Engineering: Integrated Design and Manufacturing

1.4. Course numbering scheme

Normally, every course at IIT Hyderabad runs for the full length of the semester. Each course is denoted by six alpha-numerals course number, two alphabets followed by four numerals:



ENGINEERING SCIENCE

Course No	Course Name	Credits	A full Semester					
			Time Segments when it runs					
			1/6	2/6	3/6	4/6	5/6	6/6
SEM – 1								
ID1054	Digital Fabrication	2						
ID1200	Introduction to programming	2						
ID1201	Introduction to programming Lab	1						
ID1035	Independent Project	1						
EE1110	Boolean Algebra	1						
MA1110	Calculus-I	1						
MA1220	Calculus-II	2						
EE2010	Computer Organization	1						
Laxxxx	Liberal and Creative Arts Electives	2						
CY1017	Environmental Chemistry-1	1						
EE2110	Digital Systems and Design	1						
XXxxxx	Free Elective	2						
SEM – 2								
BO1010	Introduction to Life Sciences	1						
Laxxxx	Liberal and Creative Arts Electives	2						
CS1230	Introduction to Data Structures	1						
CS1231	Data Structures Lab	2						
ID1140	Thermodynamics – I	1						
MA1130	Vector Calculus	1						
MA1140	Linear Algebra	1						
MA1150	Differential Equations	1						
PH1027	EM and Maxwells Equation	1						
CY1027	Dynamics of Chemical Systems-I	1						
EE1170	Embeded programming	1						
PH2027	Quantum Physics	1						
BM1050	Brain Machine Interface	1						
XXxxxx	Free Elective	2						
SEM – 3								
EE1010	Electric Circuits	1						
MS1050	Physics of Solids	1						
CY1030	Environmental Chemistry-II	2						
PH1017	Classical Physics	1						
BM1030	Bio-engineering	1						
ID1100	Fluid Mechanics-I	2						
EE2010	Device Physics	2						
PH2117	Photonics	1						
CS2210	Theory of Computation-1	1						
CS2200	Algorithms-1	1						
CS2250	Computer Networks-1	1						
CH2070	Numerical Methods-1	2						

Course No	Course Name	Credits	A full Semester					
			Time Segments when it runs					
			1/6	2/6	3/6	4/6	5/6	6/6
Laxxxx	Liberal and Creative Arts Electives	2						
XXxxxx	Free Elective	2						
SEM - 4								
MA2140	Statistics	1						
MA2130	Complex Variables	1						
CH2140	Numerical Methods-2	2						
ME2070	Introduction to Mathematical Modelling	1.5						
CS2300	Algorithms-II	2						
CS2310	Theory of Computation II	2						
ME1020	Dynamics	2						
BM1040	Neuromuscular Physiology	1						
EE2160	Embedded Programming	1						
EE2140	CMOS Fabrication	1						
EE2220	Control systems	1						
MS1070	Semiconductor Materials	1						
LAxxxx	Liberal and Creative Arts Electives	2						
XXxxxx	Free Elective	2						