COURSE INFORMATION BOOKLET

2019-20

INDIAN INSTITUTE OF TECHNOLOGY BOMBAY




A guide to all courses in IITB

Undergraduate Academic Council
UGAC

Student Support Services

CONTENTS

DISCLAIMER

The information written in the booklet is only a guideline to the students to help them with their choices in the courses they make and also in the various important features of the Institute academic system.

It may happen that the actual details of courses or rules mentioned in the booklet may face an amendment or change any time. Please confirm the rules/details from relevant authorities before making any decisions.

The Academic Council members can be contacted for this purpose (details shared on the last page of the booklet).

PREFACE

Dear Students,

This information booklet has especially been made for you!

Through this booklet we aim to open doors for your way ahead with academics in IIT Bombay, this booklet will help you make a choice beyond what you would learn in your core curriculum, pursue courses by keeping in mind your true interests and future aspirations.

This booklet will tell you about the various options available to you for pursuing your true passion and hopefully make learning more enjoyable and wonderful for you. This booklet will tell you about the various categories of courses, the advantages of doing a minor and how you should go about finding a minor program which suits you in all respect!

If you have missed out exactly what you wanted to learn because of your JEE rank this is the time to cover up for it! A minor program will help you far beyond than what you think and in this world of cutting edge interdisciplinary research will help you mold yourself into a good engineer or scientist. We are open to suggestions and ideas from your side to improve this booklet.

Wishing you a good stay at IIT Bombay and a bright future!

Best Wishes,

Vishnu Nair
Institute Secretary of Academic Affairs
Head – Student Support Services (2013-2014)

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We would also like to thank all the DAMP Teams, DGSecs and the offices of the departments for reviewing the course descriptions and also to all the people whom we might have missed above for their contribution in providing the updated information.

SECTION 1: CATEGORY OF COURSES

1.1. CORE COURSES

Core courses are those courses which you have to do compulsorily for obtaining your degree. These courses count towards your final degree in all respects and count in your core CPI (Cumulative Performance Index). These courses are **NOT** optional and have to be completed within the stipulated duration of your coursework (4 or 5 years). They give you a lot of exposure to your own departmental subjects and research; They also have an elective component, details regarding which are explained in the section on electives.

1.2. MINOR COURSES

A Minor is an additional credential, a student will earn if he/ she does minimum 30 credits worth of additional learning in a discipline other than his/ her major discipline. Most of the academic units in the Institute offer minors in their disciplines, and prescribe a specific set of courses and/ or other activities like projects for earning a minor in that discipline. Note that, courses equivalent in content to any of these specified courses from the same dept. can be taken as a minor course with the approval of the concerned HOD. After the completion of credits under the stipulated time period, a minor degree is awarded to the student. It is mentioned in the Degree Certificate "Bachelor of Technology in xxx with Minor in yyy." The fact will also be reflected in the transcript along with the list of courses taken.

Minor courses are allocated to students through a pre-registration process before the start of every semester and the allocation for every minor course is done on the basis of CPI of the student as the seats are limited in every minor course. If you miss out on the allocation of a minor course due to CPI constraints you can avail a position in the waitlist for a course so that if some student drops the course you can take up the seat (Wait list allocation would be a first come first serve though, and depends on the time that you enrolled in the waitlist at the time of registration).

Dual degree students are allowed to register for a minor only if they have a CPI above 8.0. Back loggers will not be allowed to take up minor courses until they clear them. Minor courses do not count in your core CPI.

1.3. HONOR COURSES

Honor/ Honour is an additional credential a student will earn if he/ she opts for the extra 24 credits (in some cases, 30) needed for this in his/ her own discipline. The concerned department specifies the course requirements for earning the Honors. An Honor is like a specialisation in your own discipline.

Honor courses are either advanced level courses in your discipline or are courses designed to give you more exposure to different areas of your discipline. On successful accumulation of credits at the end of the programme, this will be mentioned in the Degree Certificate “Bachelor of Technology in xxx, with honours.” The fact will also be reflected in the transcript, along with the list of courses, etc. taken. Dual Degree students have to do the Honors courses by default. They are considered as their core courses. Honor courses do not count in your CPI other than for dual degree students.

You can register for an Honor and minor both together if you have a CPI>8 with no backlogs.

1.4. ELECTIVES

Every programme (B.Tech/ M.Tech/ Int. M.Sc.) in IIT Bombay will have its own curriculum defined, which will define your core courses and the total credit requirement for the award of the degree. According to your curriculum your course completion may require doing courses of your own choice, wish and interest from:

1) **Dept. of Humanities and Social Sciences- Humanities Elective**
   All undergraduates are required to do a Humanities elective from HSS department in their third year and you have to choose this elective from the following set: HS 301 - Philosophy, HS 303 - Psychology, HS 307 - Sociology, and HS 309 - Introduction to the Study of Language.

2) **Your own department- Department Elective**
   As per your curriculum, you may be required to choose a few courses (Number varying across programmes) of higher level (Say 4xx or 5xx) from your department across a pool of courses put forward by your department.

3) **A department other than yours- Institute Elective**
   As per your curriculum, you may be required to choose a few courses (Number varying across programmes) from a foreign department. Generally, you are free to choose any course out of your department (Except 1xx courses and some of

the IDC courses, you ask the concerned faculty and HOD to ask if they will allow a particular IDC course to be tagged as institute elective) as Institute electives. Instructor/ Departmental based restrictions may be there.

All these electives are a part of the core curriculum and will count in your CPI.

NOTE:

No management course can be tagged as an institute elective.

List of courses can be obtained on the department website.

HSS Course Codes are changed every year; thus search the course by its name; not by its code.

1.5. ADDITIONAL LEARNING COURSES

According to the rule of maximum credit limit one can take maximum credits based on his/her academic standing. To reiterate here is the rule

Category I - 54 credits

Category II,III,IV - 48 credits

Category V - 30 credits

Students who have accumulated five or more FR and DX in program defined core courses - 24 credits

Exceeding any of the above is NOT admissible under any circumstances.

If the rules are followed one can take some extra courses. Additional learning courses can be credited or audited. These ALC courses don't constitute the core CPI/SPI of a student. The tag of such a course can be changed during the retagging period which is explained later.

SECTION-2 : WHY MINORS

Minor courses allow you to officially explore a department other than your own while at the same time getting credit for it. It adds value to your major degree and can be a gateway to get opportunities in the field you have completed your minor in. Your minor degree can give you sufficient knowledge to enable you to take part in interdisciplinary research and even pursue your higher studies in such fields. Though a minor degree can be pursued simply out of genuine and deep interest in a particular department without any specific end goal in view, for the general majority, you should select it in such a way that it either suits your major degree in a research-oriented interdisciplinary manner or in a generic way to any engineer or scientist.

Before you select a minor, try to find what you are truly interested in. It is surely not easy for everyone to be crystal clear about this, but even a vague idea will help you enjoy the minor courses and truly enrich the experience. You can always sample courses from various departments to find this interest, but you lose the benefit of a minor degree in doing so.

You can select any minor course from any department but to draw the complete benefit out of it you should look for overlap between them and your discipline so that it supplements your learning. You should also look at how all the minor courses fit in with each other for a more holistic approach; some departments draw up a suggested schedule of when each minor course must be taken to reap the full benefits out the curriculum. Minor courses don't count in your CPI, so you should select a minor based on your interest.

Listed on the next page is a suggested set of minor programs which may suit each branch. This matching is done by looking at how much overlap each discipline has with respect to other fields, so that the minor programs can support interdisciplinary learning of each student depending on his career plans. Use it only as a guide and not a binding set of rules; don't let it dissuade you from pursuing what really interests you:

Minor Programme	Suitable Branches
Aerospace Engineering	Mechanical, Electrical, Civil
Biosciences and Bioengineering	Chemistry, Engineering Physics, Chemical, Electrical, Metallurgical Engineering and Material Sciences, Energy
Chemistry	Engineering Physics, MEMS, Electrical, Chemical, Energy
Chemical Engineering	Chemistry, Mechanical, Electrical, Energy
Centre of Studies in Resources Engineering (CSRE)	Electrical, Computer Science, Engineering Physics
Computer Science and Engineering	Suits all!
CTARA	Suits all!
Electrical Engineering	Engineering Physics, Chemistry, Chemical, Mechanical, MEMS, Energy, Aerospace, CSE
Energy	Mechanical, Chemical, Aerospace
Entrepreneurship	Suits all!
Environmental Sciences and Engineering	Chemistry, Chemical, Civil
Humanities and Social Sciences	Suits all!
Industrial Design Centre	Suits all!
IEOR	Suits all!
Mathematics	Suits all!

Mechanical Engineering	Civil, Electrical, Aerospace
Management	Suits all!
Physics	Chemistry, Chemical, Electrical, Mechanical, MEMS
Statistics and Informatics	Suits all!
Systems and Control Engineering	Engineering Physics, Electrical, Mechanical, Civil, Chemical, Aerospace

SECTION-3 : WHY HONORS

Honor courses are either advanced level courses in your department or are courses designed to give you more exposure to different areas in your department. They help you get deeper knowledge in your department to better prepare you for higher studies or to take a job in a certain specialized area, so that you can compete with, say, an M.Tech who has specialized in the same area. You are likely to develop strong subject skills by completing an honor successfully and sincerely. Undergraduate classes introduce you to a wide breadth of topics and challenges, and an Honors project enables you to explore one in much greater depth. Honors research topics are varied and negotiable – if you are really interested in a topic and want to learn more about it, you'll be encouraged and supported.

From a potential employer's perspective, whatever your department, it appears laudable to have demonstrated ability in achieving a complex and demanding goal and having in-depth knowledge in your department. Honor courses also help you if you want to pursue further studies or research in the future. The deeper understanding and chance to explore sub-domains assists in making an informed choice about the topic of future exploration. Also since you have more dedicated knowledge in your specialization, there are higher chances that your profile will get noticed by universities for their MS/PhD programs.

To complete the honor, 24 credits must be completed by tagging courses in your department as honor electives and they don't count in your CPI; a separate Honors CPI is maintained. This means that taking some honor courses but not being able to complete the entire 24 credits does not harm you in any way; it, in any case, enables you to delve further into your department.

SECTION-4 : TAGGING RULES

Every course that you do in the institute falls under one of the categories of courses as described in the section 1 and hence a tag is given to the course that you have done, in order to classify them. The tags of electives can be changed as per the rules that follow. This facility allows students to do additional courses and finally make select courses count towards 'Core CPI' (the CPI of prescribed curriculum credits;

Rules: Re-tagging will be available to students **ONLY TWICE** in their entire program duration, first time before placements (Second Last Semester Starting) and second time post curriculum completion (Last Semester). The courses that have been re-tagged during the opportunity given during the previous window will be debarred from the re-tagging process.

NOTE: From year 2017 onwards, the tagging window for Category I DD Students will also be the same as the re-tagging window of their B.Tech counterparts (those who are graduating). For them (Category I DD students), the second window for re-tagging will be made available at the time of graduation. This has been done to ensure a fair process of selection for the institute medals.

For the rest of the categories' DD students, first tagging window will be opened in the Autumn Semester before placements and the second one at the time of their graduation.

Tags of courses:

1) Core Course- C
2) Department Elective - D
3) Institute Elective - I
4) Additional Learning Minors- M
5) Additional Learning Courses - T
6) Honors course - O

An approved change of tag will result in fresh calculation of SPI/ CPI from the semester the tag change has been made effective due to the fact that additional learning course(s) do NOT constitute the core SPI/ CPI of a student.

On the next page is given a table specifying the current rules about the changing of tags from one to another and the restrictions put on the same:

TAG CODE	TAG DESCRIPTION	CHANGEABLE INTO
T	Additional Learning	D,I,O
C	Core Course	Not Changeable
D	Department Elective	O,T
O	Honours Course	D,T
H	Humanities Elective	T
I	Institute Elective	T
M	Minor Course	I,T

Note:

For any special requests i.e. a change, which cannot be implemented on the tagging interface, the student has to get an approval from his/her Faculty Advisor and HOD of concerned department (other department in case of minors).

SECTION-5 : MINOR COURSES OF DIFFERENT DEPARTMENTS

This section gives a comprehensive description of the minor, and the course contents and the major topics covered in the minor courses of various departments.

5.1 AEROSPACE ENGINEERING

PREFACE:

The Aerospace Engineering minor develops the engineering-analysis and design skills necessary for creating and understanding aerospace vehicles and their subsystems. The minor includes diverse topics relevant to applications both in the Earth's atmosphere (e.g. aerodynamics) and in space (e.g. spacecraft thermal systems or orbital mechanics). Aerospace Engineering is broadly divided into four sub-groups: Structures, Aerodynamics, Propulsion and Control & Navigation.

COURSES:

Minor in aerospace engineering is composed of two components; a compulsory part containing the following two courses and a minor basket for choosing the remaining three courses.

AE 153 – Introduction to Aerospace Engineering (Offered in III Semester)

This is the Department Introductory Course (DIC) for aerospace engineering and introduces students to the fundamentals of fluid mechanics and basic aerodynamic phenomenon. Course contents: Nomenclature of aircraft components. Standard atmosphere. Basic Aerodynamics: Streamlines, steady fluid motion, incompressible flow, Bernoulli's equation, Mach number, Pressure and airspeed measurement, Boundary Layer, Reynolds number, Laminar and Turbulent flow.

Aerofoils and wings: pressure coefficient and lift calculation, Critical Mach number, Wave drag, Finite wings, induced drag and swept wings. Aircraft performance: steady level flight, Altitude effects, Absolute ceiling, steady climbing flight, Energy methods, Range and Endurance, Sustained level turn, pull-up maneuver, V-n diagram, Take-off and landing. Re-entry vehicles: Ballistic and Glide Reentry, Blunt body concept.

AE 415M – Spaceflight Mechanics (Offered in IV Semester, Prerequisite: AE 153)

Both these courses are to be offered in slot 5 with applicable semester restriction. Students desirous of minor in aerospace must complete these two courses, in the specified sequence, before choosing courses from basket.

Minor Basket:

In addition to the above two courses, students pursuing a minor in aerospace engineering are required to complete three more courses over the remaining four semesters (V, VI, VII & VIII), by choosing courses from minor basket below. As a rule, they are required to do any three courses from the two sets, but can do a maximum of two from any one set).

First set: Autumn Semester::

AE 227M – Solid Mechanics (Not available to students of CE, ME, EN)

This course falls under the Structures sub-group of Aerospace Engineering and deals with the basics of Solid Mechanics. Contents of this course are generic to Mechanical, Civil and Energy Engineering. Topics include: Euler-Bernoulli Beam Theory, Truss Structures, Cauchy Stress Tensor, Buckling of Columns, Mohr's Circle.

AE 225M – Incompressible Fluid Mechanics (Not Available to students of CE,ME,EN,CL)

This course falls under the Aerodynamics sub-group of Aerospace Engineering. It is the first part of the module of Fluid Mechanics and focuses on the elementary physics of Fluids. Course contents: Definition of Fluids and parameters associated with them, Pascal's Pressure Law, Reynold's Number, Bernoulli's Principle, Euler Equation, Potential Flow Theory, Viscosity in Fluids, Navier-Stokes Equation.

AE 223M – Thermodynamics and Propulsion (Not Available to students of CE, ME, EN, CL)

This course falls under the Propulsion sub-group of Aerospace Engineering. It deals with the basics of Thermodynamics and the briefly focuses on the aspects which are specific to Aircraft and Rocket Engines. Topics include: Laws of Thermodynamics, Types of thermodynamic processes, Carnot Engine, Carnot Cycle, Otto Cycle, Diesel Cycle, Brayton Cycle, Outline of an Aircraft Engine, Heat Transfer.

AE 234M – Aircraft Propulsion (To run with AE 711, prerequisite: AE 223M or equivalent)

This course falls under the Propulsion sub-group of Aerospace Engineering. It deals in detail with the different parts of an Aircraft Engine and their analysis. Topics include: Brayton Cycle, Brayton Cycle with Reheating, Regeneration and Intercooling, Aircraft Engine Intake, Axial and Centrifugal Compressors, Turbines, Nozzles and Afterburners.

AE 236M – Compressible Fluid Mechanics (To run with AE 616, prerequisite: AE 225M or equivalent)

This course falls under the Aerodynamics sub-group of Aerospace Engineering. It is the second part of the module of Fluid Mechanics and focuses on the physics of Compressible Fluids. Topics include: Compressibility, Mach Number, Adiabatic Compressible Flow Relations,Shock Waves, Expansion Waves, Shock Tube Experiment.

AE 238M – Aerospace Structural Mechanics (To run with AE 709, prerequisite: AE 227M or equivalent)

This course falls under the Structures sub-group of Aerospace Engineering and deals with the aspects of Solid Mechanics relevant to Aircraft flight. Topics include: Flight Envelope, Torsion, Membrane Analogy, Thin Walled Beam Theory, Warping, Torsional Buckling, Shear Flow, Structural Instability Analysis.

AE 305M – Flight Mechanics (To run with AE 305)

This course jointly falls under the Control & Navigation and Aerodynamics sub-groups of Aerospace Engineering. It emphasizes on the dynamic behaviour of an aircraft in flight and its associated phenomena. Topics Include: Equilibrium, Static Stability and Control, Longitudinal Stability and Control, Trim Condition, Hinge moments, Neutral Point, Lateral Stability, Equations of Motion, Euler Angles, Body-fixed axis, wind axis, stability axis, Phugoid Mode, Short-Period Oscillations, Dutch Roll.

AE 4xxM – Modelling and Simulation (To run with AE 4xx)

This course falls under the Control & Navigation sub-group of Aerospace Engineering. It deals with the concepts of Modelling a System and performing Simulations. Course contents: Modelling techniques, Types of Simulations, Mechanical Systems, Electrical Systems, Hydraulic Systems

AE 333M – Aerodynamics (run with AE 333, prerequisite: AE 225M, AE 236M or equivalent)

This course falls under the Aerodynamics sub-group of Aerospace Engineering.It focuses on the specifics of Aerodynamics involved in an aircraft flight. Contents: Potential Flow Theory, Thin Airfoil Theory, Vortex Sheets, Lifting Line Theory, Effects of taper and sweep.

AE 3xxM – Vibrations and Structural Dynamics (To run with AE 3xx, prerequisite: AE227M or equivalent)

This course falls under the Structures sub-group of Aerospace Engineering. It deals with the Dynamics of structures and the associated phenomenon. Topics include: Modal Analysis,

Analysis of Multiple-DOF Systems, Dynamic Instabilities in Structures, Effects of Damping and Stiffness, Energy Methods.

Second Set: Spring Semester:

AE 234M – Aircraft Propulsion (To run with AE 234)

This course falls under the Propulsion sub-group of Aerospace Engineering. It deals in detail with the different parts of an Aircraft Engine and their analysis. Topics include: Brayton Cycle, Brayton Cycle with Reheating, Regeneration and Intercooling, Aircraft Engine Intake, Axial and Centrifugal Compressors, Turbines, Nozzles and Afterburners.

AE 236M – Compressible Fluid Mechanics (To run with AE 236, prerequisite: AE 225M or equivalent)

This course falls under the Aerodynamics sub-group of Aerospace Engineering. It is the second part of the module of Fluid Mechanics and focuses on the physics of Compressible Fluids. Topics include: Compressibility, Mach Number, Adiabatic Compressible Flow Relations,Shock Waves, Expansion Waves, Shock Tube Experiment.

AE 238M – Aerospace Structural Mechanics (To run with AE 238, prerequisite: AE 227M or equivalent)

This course falls under the Structures sub-group of Aerospace Engineering and deals with the aspects of Solid Mechanics relevant to Aircraft flight. Topics include: Flight Envelope, Torsion, Membrane Analogy, Thin Walled Beam Theory, Warping, Torsional Buckling, Shear Flow, Structural Instability Analysis.

AE 3xxM – Aerospace Propulsion (To run with AE 3xx, prerequisite: AE 225M, AE 236M or equivalent)

This course falls under the Propulsion sub-group of Aerospace Engineering. It is complementary to the Aircraft Propulsion Course and deals with the thermodynamic analysis of Rocket Engines and the phenomenon associated with them. Topics Include: Types of Rocket Engines, Parts of a Rocket Engine, Fuel Analysis of Rocket Engines, Flight Trajectory of a Rocket Engine.

AE 332M – Aircraft Design (To run with AE 332, prerequisite: AE 305M or equivalent)

This course is specific to the design of an aircraft and deals with the aspects of Aircraft Performance. Topics Include: Types of Civil and Military Aircrafts, Design Process of an Aircraft, Sizing of an Aircraft, Weight estimation, Rubber Engine Sizing, Range-Payload Diagrams, V-n diagrams, Aircraft Rules and Regulations, Comparison of various Aircraft Configurations.

AE 308M – Control Theory (To run with AE 308)

This course falls under the Control & Navigation sub-group of Aerospace Engineering. It is an elementary course dealing with the basics of Classical Control Theory. Course contains: Laplace Transforms, Open Loop and Closed Loop Systems, Root Locus, Pole -Zero Placement, PID Control, Bode Plot, Nyquist Plot.

AE 4xxM – Navigation and Guidance (To run with AE4xx)

This course falls under the Control & Navigation sub-group of Aerospace Engineering. It describes the basic theory behind Navigation and Guidance of Aircrafts, Rockets and Missiles. Topics include: Working of RADARs, Continuous Wave RADARs, Navigation Theory, Observability, Kalman Filter Design, EKF, Guidance Laws for Missiles.

All minor registrations will be carried out in consultation with minor coordinator Prof. Viren Menezes.

5.2 BIOSCIENCES AND BIOENGINEERING

PREFACE:

The minor elective courses from this Department include courses from both the Bioscience and Biomedical fields, providing a short introduction to each so that students can pursue whichever of them catches their attention. The Biosciences courses will be useful for Chemical Engineering, Chemistry and Physics branches. The Biomedical courses will be useful for the above, in addition to Electrical Engineering and MEMS students.

COURSES:

BB 400 – Molecular Biophysics :

Molecular structure; Torsion angles; Steric effect: Contact distances; Homomorphous sugars; Cis & trans peptide bonds; Ramachandran map: for amino acids and as a general conformational analysis tool. Non-covalent interactions; hydrogen bond; stacking; Entropy: Entropy/enthalpy compensation; A=T vs. GºC. Effective conc. Enthalpic and entropic cooperativity. Oligopeptide conformation. Conformationally constrained amino acids; Hydrophobic effect; Affinity and specificity in intermolecular interactions; Stability of protein structure; Folding / unfolding; m values; Models of protein folding; Folding funnel; Contact order; F value analysis; Denatured state; Intrinsically unfolded proteins; Protein and RNA folding; In vivo folding; Kinetically stable proteins; Lipids: Assemblies; Volume, surface area, length relationship; X-ray studies; Phase transitions of anhydrous and hydrated lipid bilayers.

BB 404 – Metabolism and Bioenergetics:

Overview of metabolism; concept of flow of matter and energy; thermodynamics of coupled systems and non-equilibrium reactions; biological energy currencies: high energy bond, reducing power and interconversions of energy forms; carbon, nitrogen cycles in biosphere; classification of living system based on carbon and energy requirements; methods to study metabolism; carbohydrate and lipid catabolism; glycolysis; TCA cycle; fatty acid oxidation, other metabolic routes of carbon; oxidative phosphorylation; biosynthesis of carbohydrates and lipids photosynthesis; photosynthetic electron transport; Calvin cycle and other avenues of harvesting light energy; gluconeogenesis; Cori cycle; glycogen metabolism; biogenesis of fatty acids and sterols; nitrogen metabolism: sources of organic nitrogen; flow of nitrogen into biosynthesis and catabolism of amino acids; central role of glutamine; purines and pyrimidines; the metabolism of nucleotides; urea cycle and excretion of nitrogen; integration of metabolism and concepts of metabolic regulation.

BB 405 - Molecular Biology:

Nucleic acids, DNA structure, central dogma; Replication: eukaryotic and prokaryotic replication, mechanism and control, replication of double stranded and single stranded circular DNA, the end-replication problem and telomerase; Nucleosomes: eukaryotic and prokaryotic genome packing, heterochromatin, euchromatin; Transcription: mechanisms of RNA transcription in prokaryotes and eukaryotes; model systems of transcriptional control: lac operon, lambda phage; promoters, enhancers, repressors; RNA processing: processing of heterogeneous nuclear RNA: splicing, capping, polyadenylation; Translation: universal genetic code, degeneracy of codons, mechanisms of initiation, elongation and termination of translation, wobble hypothesis, genetic code in mitochondria; Mutations: nonsense, missense, frameshift and point mutations; intragenic and intergenic suppression; DNA repair: photoreactivation, excision, mismatch and SOS repair; Recombination: mechanism of homologous recombination in prokaryotes, site specific recombination, insertion sequences, Transposons.

BB 411 – Introduction to Molecular Cell Biology :

Biochemical unity and biological diversity. Relationship between structure and function. Separation techniques: basis and importance. Microbial kingdom. Prokaryotes, eukaryotes, archaea. Microbial growth. Hemoglobin: portrait of an allosteric protein. Enzymes. Catalytic and regulatory strategies. Carbohydrates, lipids, membranes. Signal transduction. Metabolism: basic concepts and design. Oxidative and photophosphorylation. Integration of metabolism. Flow of genetic information. Recombinant DNA technology. Genomes. Concept of homology.

BB 503 – Genetic Engineering :

Concept of recombinant DNA technology and purpose, basic methodology, use of plasmids, Type I, II and III restriction modification systems, type II restriction endonucleases, nomenclature and sequence recognition, mcr and rnrr genotypes, linkers, adaptors, blunt end ligation, homopolymeric tailing, Transformation, methods in screening recombinant DNA.

Radioactive and nonradioactive methods for labeling DNA: Nick translation, random priming, use of Klenow enzyme, T4 DNA polymerase, bacterial alkaline phosphatase, polynucleotide kinase, hybridization techniques, northern, Southern and colony hybridization. Restriction maps and mapping techniques. PCR technology, enzymes in PCR, hot-start, touchdown PCR, primer design, introduction of restriction sites etc. Construction of cDNA libraries in plasmids, hybrid select translation, RT-PCR and quantitative RT-PCR. Strategies for maximizing gene expression, prokaryotic expression vectors; pMal, GST fusion vectors, pET vectors and their applications in expression, quantitation, purification. Inclusion bodies, approaches to solubilization, Intein based expression and purification vectors. Cloning in M13 mp vectors, application to DNA sequencing, site-directed mutagenesis; PCR-based mutations. Transcription vectors. Lambda vectors; insertion and replacement vectors, selection and screening recombinant phage, in vitro packaging, genomic libraries and cDNA cloning, application of lgt 10, lgt 11, lZAP vectors. Cosmid vectors. Yeast transformation, yeast cloning vectors, specialized vectors such as gap and retrievers, principles and application of dihybrid systems. Cloning and expression in mammalian cells, methods of selection and screening, application of reporter genes. Basic principles of transcriptomics and proteomics.

BB 507 - Molecular Enzymology :

Rate accelerations in biological systems; Catalysis and historical perspective on enzymes; Overview of applied enzymology and enzyme technology; Enzyme nomenclature; Origins of enzyme catalytic power; Structural basis of enzyme action and characterization of active site residues; Kinetic approaches to understand enzyme action; Michaelis-Menten kinetics; Evaluation of Km, kcat and enzyme inhibition analysis; Concept of an efficient catalyst; Elucidation of kinetic mechanism through initial velocity, product inhibition, pH and isotopic analysis; Role of metal ions in enzyme catalysis; Integration of kinetic, chemical and structural data to describe enzyme action; Control of enzyme activity and its role in regulating metabolism – in vivo enzymology; Frontiers in enzymology: Rational design of an enzyme catalyst, directed evolution, abzymes, non-protein catalysts.

BB 603 – Physiology for Engineers:

Basic cell physiology; Biochemical cycles. Systemic physiology: Neuromuscular system; Blood and lymph; Circulatory system; Respiratory and Cardiovascular system, Gastrointestinal system; Kidney and excretory system; Sensory systems- visual, auditory, vestibular; Endocrine-pituitary, adrenal, pancreas, Clinical and technological implications.

BB 605 – Genetics and Evolution of Biological Circuits:

Introduction to Bionanotechnology, Cellular nanostructures, self-assembly of colloidal nanostructures of biological relevance, bioactive nanoparticles (respiratory surfactants, magnetic nanoparticles), Nanoparticles for drug delivery (including solid lipid nanoparticles, synthetic and bio polymeric nanoparticles), carbon nanotubes, polymeric nanofibers,

Implications in neuroscience, tissue engineering and cancer therapy, and Environmental and safety aspects of bio-nanotechnology. Introduction to Nanotechnology, Multilayer Thin Film: Polyelectrolyte multilayers, coated colloids, smart capsules, LbL self-assembly, Colloids and Colloid Assemblies for Bio-nanotechnology, Nano Engineered biosensors, Fiber Optic Nanosensors in medical care, Semiconductor and Metal Nanoparticles: Synthesis and Applications, Nanotechnology in Tissue Engineering, Microemulsions and Drug Delivery in Nanotechnology.

BB 610 – Biomedical Microsystems:

Introduction; photolithography; mask design; wet and dry etching; thin film deposition and growth, electroplating, molding, LIGA, bonding and sacrificial processes, polymer processing and rapid prototyping, biomaterials and biocompatibility issues, micro total analysis system (μTAS): Fluid control components, μ-TAS: sample handling, μ-TAS: separation components, μ-TAS: detection, cell handling and characterization systems, systems for biotechnology and PCR, polynucleotide arrays and genetic screening, miniature biosensors, biosensors arrays and implantable devices, neural interfaces, microsurgical tools, microneedles, and drug delivery, miniature bioreactors and Microsystems for tissue engineering, tissue scaffolds, optical biosensors, MEMS metrology, MEMS packaging.

Detailed course contents can be found on the departmental website:

www.bio.iitb.ac.in/academics/minor-courses

5.3 CENTRE FOR STUDIES IN RESOURCES ENGINEERING

PREFACE:

Modern technologies like Geographic Information System (GIS), Global Positioning System (GPS), Satellite image processing and Remote Sensing, are extensively used in the Centre's in teaching, research, consultancy and continuing education programmes. CSRE has been active in contributing significantly towards the needs of developing and demonstrating the technology of satellite data utilization and development of Geographic Information System. The Centre has successfully demonstrated the application potential of remote sensing technology in the programs of disaster mitigation like drought and flood along with national agencies such as ISRO and NRSA.

COURSES:

GNR 401 – Remote sensing and Image processing:

Remote sensing is the acquisition of information about an object or phenomenon, without making physical contact with the object. In modern usage, the term generally refers to the use of aerial sensor technologies to detect and classify objects on Earth (both on the surface, and

in the atmosphere and oceans) by means of propagated signals (e.g. electromagnetic radiation). In imaging science, image processing is any form of signal processing for which the input is an image, such as a photograph or video frame; the output of image processing may be either an image or a set of characteristics or parameters related to the image. Most image-processing techniques involve treating the image as a two-dimensional signal and applying standard signal-processing techniques to it.

GNR 403 – Geo-informatics Lab:
Tutorial on Spatial data generation, management, modeling, analysis and applications; on satellite image georeferencing, enhancement and filtering, transformations, classification and accuracy assessment and applications Laboratory sessions involving use of state-of-the-art GIS and image processing software to get familiarized with handling and analyzing spatial datasets including satellite images Reading and discussing papers/reports on image processing / GIS / applications.

GNR 405 – Mini Project:
This involves a small independent study on a problem identified by the student and the faculty member supervising it. The mini- project may focus on a problem involving application of geo informatics tools and techniques.

GNR 407 – Natural hazards and Disaster management:
Classification of disasters, natural, man-made, technological; scale, intensity and frequency of disasters, hazard zone mapping, risk assessment, vulnerability mapping, extreme event analysis; Forecasting, early warning systems, disaster preparedness, monitoring techniques, response and disaster management, rehabilitation and reconstruction strategies; Case studies on flood, droughts, snow avalanches, landslides, earthquakes.

GNR 409 – Terrain Evaluation and Land use planning:
Terrain unit, generalization of terrain, terrain classification: conventional and geomorphological approach, groundtruth collection, sampling schemes, integrated land survey methods, conventional approach to terrain evaluation systems, Quantitative terrain evaluation, drainage analysis, soil mapping, applications of remote sensing and GIS in civil engineering projects: geotechnical appraisal, site selection, route alignment, irrigation projects, urban planning and development and case studies.Resource-informatics for decision making; land use/cover and its dynamics; land degradation, conservation and rehabilitation; land use planning, case studies

GNR 411 – Integrated Coastal Management:Coastal and ocean scenario:
coastal geomorphological processes and land cover, biological, physical and chemical aspects of oceans, marine pollution, causes and impacts Coastal hazards- cyclones, storm surges, tsunamis, shoreline change and sea level changes, saltwater intrusion, wetlands and their role in marine ecological systems , carbon cycle, ocean atmosphere interactions and global

warming, El Nino La Nina, Need and basic concepts of ICM, ICM history, prevalent legislations, case studies Use of Remote Sensing and GIS in ICM.

5.4 CENTRE FOR TECHNOLOGY ALTERNATIVES FOR RURAL AREAS (CTARA)

The Centre for Technology Alternatives for Rural Areas (CTARA) Department does not offer a minor as such for the undergraduates but instead has a **Technology and Development Supervised Learning (TDSL) program** for them. These courses offer the students an opportunity to work on a live project, urban or rural, which involves direct interaction and interface with the larger society and stakeholders.

All the projects offered through TDSL fall under **3 broad categories- Study, Analysis and Design.** The output of the project could be in the form of policy recommendations and studies, protocols or design solutions. Projects are floated by the faculty members and student interested in a particular topic may directly approach to work with the faculty member on the project.

Structure of the course-

The courses offered are as follows:

TD390 Supervised Learning-Study -6 credits
TD490 Supervised Learning-Analysis -6 credits
TD491 Supervised Learning-Design- 12 credits

TD 390 is a study, i.e., a report of a field situation to people in IIT. TD 490 is an analysis in addition to the study and must be shared with the stakeholders. The outcome of the study must have content which is of interest to the stakeholders. The TD 390/TD 490 will largely involve gathering of data, field work, study and analysis. TD 491 has a design component, i.e., a solution to a "development situation". Again, stakeholder participation is essential. All three courses require significant amount of field work.

The deliverables required for the project are:

1) Objective and Methodology document at the beginning of the work
2) Final report
3) Copy of the presentation

Grades will be based on these deliverables and the final presentation. For TD 490 and TD 491, it is expected that the external stakeholders be invited for the final presentation.

Registration for the students-

Courses are open to undergraduate students of all departments in their third year and beyond. Second year students will be considered in exceptional cases. Since registration is limited, students will be selected by their demonstrated interest and preparation. Applicants must have sound academic record, excellent interdisciplinary skills and motivation. If a student is interested in applying for this course, he/she has to write an essay describing the motivation to take up this course and the topic(s) of interest . Alternatively, a brief report and/or a presentation, either of a pet project or of any past experience, which demonstrates the interest in the project can be prepared.

This has to be emailed to jadhav_priya@iitb.ac.in with the Subject: TDSL registration. Students registering for TD 490 and TD 491 must pass an interview with CTARA staff/faculty. If you are selected,you have to meet your guide to discuss the scope of your project. If you mutually agree to go ahead with the project, then you must fill the registration form (downloadable from the TDSL website) and get it signed from both the faculty adviser and the TDSL course coordinator. CTARA will provide you with a moderate amount of funding (such as for travel/stay) and other infrastructure required for your project.

General guidelines for students -

- A 6 credit registration 4-5 days of field work and 50 hours of deskwork.
- 12 credit registration needs double of the above amounts. If 2 or more students work together on a project, then the total number of hours expected to be put into the project would multiply by the same factor.
- Initial contacts, references etc.must be provided by the guide. It is expected that initial stakeholder meetings would be moderated by the guide so that the student is placed on a correct footing.
- It is recommended that the students set up a fixed weekly meeting time with their guide to discuss the progress of their work.
- Students must submit an Objective and Methodology document within 4 weeks of the start of the project. This should be a 300-400 word write-up describing the project, location, deliverables, stakeholders, references and methodology. The expectation is that this will form the abstract or the introduction chapter of their final report. An example of such a document is at www.cse.iitb.ac.in/~karjat/mvs.doc. The write-up should be uploaded on Moodle within 4 weeks of the start of the semester (a reminder email will be sent).
- The final deliverable for all TDSL courses will be a presentation and a report. For TD 490 and TD 491, it is required that the external stakeholders be invited for the final presentation. A list of these stakeholders along with contact information must be submitted to the CTARA office before the final presentation. Grade will be allotted largely by the guide and may be moderated by CTARA course instructor to maintain a parity. Grades should be submitted to the instructor- in-charge (at CTARA) within a reasonable time so that it may be moderated

and transmitted to Academic Office. A day of TDSL presentations will be organized on a suitable day and is unconnected with the grading.

- CTARA will help in devising and maintaining the above framework and provide a modicum of funding. CTARA will be happy to help in liaison, preparation of the above documents and formats, and to facilitate discussions.
- The success of a TDSL (course and grade) will depend on the following---ownership of the topic under study, commitment and initiative, eagerness to go on field-visits, proper documentation and analysis, and above all an eagerness to understand the interface between engineering and real problems.

5.5 CHEMICAL ENGINEERING

PREFACE :

Chemical Engineering is a field of engineering which uses physical or life sciences like physics, chemistry, and biology and combines them with intensive use of mathematics and economics to process raw materials into substances which are useful, valuable or desired. It involves the scaling up the reactions performed in a chemistry laboratory to produce the

desired chemical on an industrial scale.

Chemical engineers deal with the transformation of raw materials into useful products that have an impact on virtually every facet of human life. However, this requires an understanding of principles of micro, meso and macro scale processes which are dealt with while doing the courses.

Within Chemical Engineering, there are two broad subgroups. One of them deals with the design, manufacture, and operation of plants and machinery in industrial chemical and related processes ("chemical process engineers") while the other deals with the development of new or adapted substances for products ranging from foods and beverages

to cosmetics to cleaners to pharmaceutical ingredients, among many other products ("chemical product engineers").

Chemical engineers work in a diverse range of responsibilities- manufacturing, supply chain, R&D, consulting, etc. Pursuing a minor in Chemical would equip you with the knowledge that is necessary while designing plants/ equipment. FMCG industries would value such skill the most since most of their work is an amalgamation of different engineering fields. The Chemical Engineering Minor would give a student an advantage in R&D the topics covered here expose you to a lot of different areas.

COURSES :

CL 152 - Introduction to Chemical Engineering:

Basic Stoichiometry, Analysis of systems with recycle, purge and bypass, Energy and Material Balances at Steady State, Single/Multicomponent system analysis, Psychometry, Chemical Processes Analysis.

CL 255 - Thermodynamics I:

Volumetric Properties of Fluids; First and Second Laws: Steady and Unsteady-State Analyses; Thermodynamic Cycles; Maxwell Relations, Thermodynamic Properties of Real Fluids; Thermodynamics of Ideal Mixtures and Solutions; Concept & Criteria of Chemical Equilibria; Vapour-Liquid Equilibria for Ideal Systems (Raoult's Law); Thermodynamics of Real Mixtures: Use of Partial Molar Properties; Residual and Excess Properties: Fugacity and Activity Coefficients; Vapour-Liquid Equilibria for Non-ideal systems.

CL 250 - Thermodynamics II:

Low/High pressure Vapour-Liquid Equilibria; Stability of Thermodynamic Systems; Liquid-Liquid Equilibria; Vapor-Liquid-Liquid Equilibrium; Solid-Liquid Equilibria; Solid-Gas Equilibria; Heat Effects of Chemical Processes / Reaction Equilibria; Thermodynamics of Electrolyte Systems; Interfacial Thermodynamics; Thermodynamics of Biosystems; Introduction to Molecular / Statistical Thermodynamics

CL 203 - Transport Phenomena:

Vectors and Tensors, Equations of Change for isothermal systems, Substantial derivatives Equations of change for Isothermal, Non-isothermal and multicomponent systems Unidirectional flows and unsteady flows, Thermal conductivity and mechanism of energy transport, Shell energy balances, Diffusivity and the mechanisms of mass transport Concentration distributions in solids and laminar flow, Heat and Mass Transfer Coefficients.

CL 324 - Chemical Reaction Engineering:

Kinetics, Reaction rate, order, rate constant, Batch reactors design and Kinetic Constants Mass and Energy balances, Catalysts and Catalytic Rates and Transport, Reactor design for ideal flow reactors, Yield and Selectivity, Residence Time Distribution, Segregation, and Maximum Mixedness models.

CL 302 - Process Control:

First Principles, Process dynamics for first, second and higher order systems, Linearization and Transfer function models, Empirical models from data, Control system instrumentation, Introduction to feedback control, Analysis of closed loop system, Frequency response using Bode and Nyquist plots, Control design techniques, Time and frequency domain techniques,

Advanced control strategies, Cascade and feedforward, Introduction to multivariable control, Controller implementation through discretisation.

NOTE: Students pursuing a minor in Chemical Engineering have to complete the courses while they are running in core course slots in the department, and not the default slot for minor (Slot 5).

5.6 CHEMISTRY

PREFACE :

Chemistry, a branch of physical science, is the study of the composition, structure, properties and change of matter. Chemistry is chiefly concerned with atoms and their interactions with other atoms - for example, the properties of the chemical bonds formed between atoms to create chemical compounds. Whatever you touch and see in chemistry and it plays a major role in every field. A Chemistry minor is ideal for Physics, Material science and Electrical engineering (In Nanoelectronics) students as they need the direct applications of chemistry in their core research fields.

COURSES :

CH 104 – Chemistry 2 :

This is the department introductory course for the 4 year BS students and has two portions, Organic and Inorganic. Inorganic Chemistry: Organometallic compounds - their synthesis, term symbols for d-block elements. Organic Chemistry: Recap of various Organic reactions and mechanisms which students have learnt in JEE.

CH 227 – Introduction to Transition Metal Chemistry :

This course starts off with a basic recap of the d block transition metal complexes, their properties and spectra interpretation and then onto inorganic photochemistry. The inorganic photochemistry deals with basics of fluorescence (excitation and emission), Jablonski diagram, and interpretation of spectra.

CH 229 – Chemical Thermodynamics :

The initial part of the course discusses basic definitions and laws of thermodynamics, which the students study during their JEE preparations. The later part of the course discusses advanced topics such as reversible cycles, irreversible cycles and fugacity to deal with real systems. An advanced version of solutions and colligative properties is also taught. The last part deals with phase transformations, phase diagrams, and binary and ternary systems.

CH 223 – Structure and Stereochemistry :

This course gives the students a good exposure onto frontier molecular orbital theory and various chemical reactions are understood using this theory. Pericyclic reactions are mainly taught for giving a good insight in understanding MOT based interpretation. The second half introduces students to the powerful tool of spectroscopy and how it's used in understanding molecular structure. Interpretation of NMR spectroscopy, Mass spectrometry, IR spectroscopy etc are taught in details.

For the fifth course for completing the 30 credit requirements of a minor you are free to choose any 4 level course (CH 4XX).

5.7 COMPUTER SCIENCE AND ENGINEERING

Preface:

Discrete mathematics lies at the core of CSE, more than the mathematics that students learn in the first year. Ability to write programs, reason about programs, modelling real life situations in programs - some level of fondness for all this will be very useful.

Other Benefits:

CSE minor will equip one with coding skills which will be useful in developing computational research methods in different fields. CSE minor will be relevant for the students interested in working in Quant companies and banks which have relevant profiles. CSE minor students are also allowed to sit for tests in companies like Google etc. during placements.

COURSES:

CS 207(M) – Discrete Structures:

Propositions and predicates, proofs and proof techniques. Sets, relations and functions, cardinality, basic counting. Posets and lattices: Dilworth's theorem, inversion and distributive lattices. Graph theory : paths, cycles, trees, connectivity. Group theory : Lagrange's theorem, homomorphisms, applications.

CS 213(M) – Data Structures and Algorithms:

Introduction to data structures, abstract data types, analysis of algorithms. Creation and manipulation of data structures: arrays, lists, stacks, queues, trees, heaps, hash tables, balanced trees, tries, graphs. Algorithms for sorting and searching, order statistics, depth-first and breadth-first search, shortest paths and minimum spanning tree.

CS 224(M) – Computer Networks

Internet architecture and the layering abstraction. Application layer: network application architectures and examples. Socket programming. Transport layer: transport protocol design, analysis of TCP. Network layer: addressing, routing, forwarding, interdomain routing. Router design and scheduling. QoS and resource allocation. Traffic engineering, network address translation and other practical topics. Link layer: channel access, switching, VLANs, MPLS. PHY layer basics: framing, encoding, modulation.

CS 347(M) - Operating Systems:

Overview of operating systems: batch processing, multiprogramming, time-sharing and real time systems. Concurrent processes: communication and synchronisation. Process management, deadlocks. Main memory management: paging, segmentation, sharing of programs and data. Device management. Information management: file system, security. A case study of UNIX.

CS 416(M) – Foundations of Network Security and Cryptography:

Vulnerabilities, risks, attacks, defences, forensics. Examples and applications of Public Key Cryptography and Secret Key Cryptography. Crypto hash, digital signatures, digital certificates and PKI. Basic Authentication and Key Agreement protocols, SSL/TLS and Kerberos. Vulnerabilities and attacks on TCP, DNS, ARP, etc. and DDoS attacks. Network/host intelligence gathering and reconnaissance methods. Web security – SQL injection, XSS, etc. Software security and buffer overflow. Malware types and case studies. Access Control, firewalls and host/network intrusion detection.

CS 419(M) - Introduction to Machine Learning:

This course will provide a broad overview of Machine Learning with a stress on applications. Supervised learning: Decision trees, Nearest neighbor classifiers, Generative classifiers like naive Bayes, Support vector Machines Unsupervised learning: K-Means clustering, Hierarchical clustering, EM, Itemset mining Applications: image recognition, speech recognition, text and web data retrieval, bioinformatics, commercial data mining.

5.8 ELECTRICAL ENGINEERING

PREFACE:

Electrical engineering is a field of engineering that generally deals with the study and application of electricity, electronics, and electromagnetism. The department is actively engaged in research areas ranging from practical implementation to theoretical investigations. A rough classification of the research areas in the department are as: Communications and Signal Processing, Control and Computing, Power Electronics and Power Systems, Microelectronics and VLSI, Electronic Systems. The aim of the minor courses offered by the

Electrical Engineering department is to give an overview of the basic subjects in the field:
(1) Communication and Signal Processing
(2) Control and Computing
(3) Analog and Digital Circuit design
(4) Device Physics.

The idea of memory elements of ROM and PLA are required as these are the basic building blocks of storage of many computational devices. In this age where processing is autonomous, the elementary knowledge of finite state machines is useful for a logical approach to programming. For any engineering system, the measured quantity is generally a signal in some form; however this signal is distorted with noise. Therefore, to obtain measurements, it is necessary to process a clean signal for precision. This is particularly useful in the process control and instrumentation sector. Chips are designed for various applications in every field of engineering, also BJT and power diodes are used for various small or high voltage applications, as a result to find definite results for point of operation, stability etc. modelling of devices is required to put them in a form which can be solved by a computer or such like. The knowledge of the characteristics of these devices helps to place them in a familiar form, thus optimizing calculations. Together these courses aim to cater to the multifarious and ever-growing needs of the industry.

COURSES: (All of the following are 6 credit courses)

EE 210 – Signals & System:

Continuous-time signals and systems: signal characteristics, common signals, properties of continuous-time systems.Continuous linear time-invariant systems: impulse response, convolution, linear constant-coefficient differential equations. Fourier series, Fourier transform Laplace transform: system analysis frequency response, analog filters. State-space analysis for continuous-time systems Discrete-time signals and systems Discrete-time LTI systems: convolution, difference equations. Sampling and Reconstruction.

EE 221 – Digital Electronics: (Will update the course code)

Review of basic combinational and sequential logic, Review of digital electronics,Digital Logic Families: TTL, CMOS etc.,Number systems and basic digital arithmetic,Finite State Machine Design, Analysis and Synthesis, Introduction to Hardware Description Language,Array based logic elements (Memory, PLA, FPGA),Special Topics (such as processor design, testing and verification, special digital systems, asynchronous state machines etc.)

EE 204 – Analog Electronics:

Introduction to operational amplifiers: The difference amplifier and the ideal operational amplifier models, concept of negative feedback and virtual short, Analysis of simple operational amplifier circuits,Frequency response of amplifiers, Bode plots.Feedback: Feedback topologies and analysis for discrete transistor amplifiers, stability of feedback circuits using Barkhausen criteria.Linear applications of operational amplifiers: Instrumentation and Isolation amplifiers, Current and voltage sources, Active filters.Non-linear applications of operational amplifiers: Comparators, clippers and clampers, Linearization amplifiers; Precision rectifiers, Logarithmic amplifiers, multi function circuits and true rms convertors. Waveform Generation: sinusoidal feedback oscillators, Relaxation oscillators, square-triangle oscillators Real operational amplifiers: Current sources and active loads, difference, intermediate and output stages including Miller capacitors for frequency computation, Operational amplifier parameters; Effects of real operational amplifier parameters on circuit performance. Analog and Digital interface circuits: A/D, D/A Converters, S/H circuits and multiplexers.

EE 207 – Electronic Devices:

Modeling devices: Static characteristics of ideal two terminal and three terminal devices; Small signal models of nonlinear devices. Introduction to semiconductor equations and carrier statistics: poisson's and continuity equations, Fermi-Dirac statistics and Boltzmann approximation to the Fermi-Dirac statistics. Semiconductor Diodes: Barrier formation in metal-semiconductor junctions, PN homo- and hetero- junctions; CV characteristics and dopant profiling; IV characteristics; Small signal models of diodes; Some Applications of diodes. Field Effect Devices : JFET/HFET, MIS structures and MOSFET operation; JFET characteristics and small signal models; MOS capacitor CV and concept of accumulation, depletion and inversion; MOSFET characteristics and small signal models. Bipolar transistors : IV characteristics and elers-Moll model; small signal models; Charge storage and transient response.

EE 325 – Probability and Random Processes:

Sets and set operations; Probability space, Conditional probability and Bayes theorem,Combinatorial probability and sampling models, Discrete random variables, probability mass function, probability distribution function, example random variables and

distributions, Continuous random variables, probability density function, probability distribution function, example distributions, Joint distributions, functions of one and two random variables, moments of random variables, Conditional distribution, densities and moments, Characteristics functions of a random variable, Markov, Chebyshev and Chernoff bounds; Random sequences and modes of convergence (everywhere, almost everywhere, probability, distribution and mean square), Limit theorems, Strong and weak laws of large numbers, central limit theorem.Random process. Stationary processes. Mean and covariance functions.Ergodicity. Transmission of random process through LTI. Power spectral density.

EE 342 – Control and Communications: (Not being offered (have to confirm))

Basic concepts: Notion of feedback, open- and closed-loop systems.Modeling and representations of control systems: Ordinary differential equations, Transfer functions, Block diagrams, Signal flow graphs, State-space representations,Performance and stability: Time-domain analysis, Second-order systems, Characteristic-equation and roots, Routh-Hurwitz criteria, Frequency-domain techniques: Root-locus methods, Frequency responses, Bode-plots, Gain-margin and phase-margin, Nyquist plots, Compensator design: Proportional, PI and PID controllers, Lead-lag compensators. State-space concepts: Controllability, Observability, pole placement result.

5.9 ENERGY ENGINEERING

PREFACE:

In view of the problem of climate change and scarcity of fossil fuels, the field of energy engineering offers significant challenges and opportunities. The Department of Energy Science and Engineering offers a minor in Energy Engineering to enable undergraduate students with different backgrounds to understand the different aspects of energy engineering. Students will be exposed to the status of energy resources, its interaction with the environment, the fundamentals of energy economics, different technologies associated with renewable energy sources, conventional power generation technologies and power generation capacity enhancement, and different techniques & technologies for energy management and energy conservation. An additional elective may be selected based on the interest from the list of electives (fuel cells, wind energy, solar thermal, solar PV, nuclear…). This provides an opportunity to explore possible options in energy efficiency and clean energy to develop sustainable energy systems.

COURSES:

EN 301 – Introduction to Renewable Energy:

Introduction to world energy scenario, Renewable energy resources, Radiation, Solar Geometry, radiation models; Solar Thermal, Optical efficiency, thermal efficiency,

concentrators, testing procedures, introduction to thermal systems (flat plate collector), solar architecture, solar still, air heater, panel systems; Photovoltaic; Introduction to semiconductor physics, doping, P_N junction, Solar cell and its I_V characteristics, PV systems components, design of a solar PV systems. Biomass, Biomass resources, wood composition, pyrolysis, gasifier, biogas, biodiesel, ethanol; Wind, Introduction, types of wind machines, Cp-l curve & betz limits, wind resource analysis; Systems, stand alone, grid connected, hybrid, system design; Hydro systems, Hydro resources, types of hydro turbine, small hydro systems; Other systems, Geothermal, wave energy, ocean energy

EN 302 – Power Generation and Systems Planning:

Overview of the Indian power sector, Thermodynamic analysis of Conventional Power Plants. Advanced Power Cycles, Kalina (Cheng) Cycle, IGCC, AFBC/PFBC, Steam Turbine - Superheater, reheater and partial condenser vacuum. Combined Feed heating and Reheating. Regenerative Heat Exchangers, Reheaters and Intercoolers in Gas Turbine power plants. Hydro power plants - turbine characteristics. Auxiliaries - Water Treatment Systems, Electrostatic Precipitator / Flue gas Desulphurisation, Coal crushing / Preparation - Ball mills / Pulverisers, ID/FD Fans, Chimney, Cooling Towers. Power plant control systems- Review of control principles, Combustion control, pulveriser control, control of air flow, Furnace pressure and feed water, steam temperature control, Safety provisions / Interlocks Analysis of System load curve -plant load factor, availability, Loss of load Probability calculations for a power system, Maintenance Scheduling Pricing of Power - Project cost components, Analysis of Power Purchase Agreements (PPA), Debt/Equity Ratio and effect on Return on Investment, Environmental Legislations/Government Policies Optimal Dispatch - Scheduling of Hydro-Thermal plants. Load Forecasting - Time series, Econometric, end use techniques. Least Cost Power Planning - Integration of DSM, Renewable into supply.

EN 410 – Energy Management:

1. Importance of energy management. Energy auditing: methodology, analysis of past trends plant data), closing the energy balance, laws of thermodynamics, measurements, portable and online instruments. 2. Energy economics - discount rate, payback period, internal rate of return, life cycle costing. Steam Systems: Boiler -efficiency testing, excess air control, Steam distribution & use- steam traps, condensate recovery, flash steam utilisation. Thermal Insulation. 3. Electrical Systems: Demand control, power factor correction, load scheduling/shifting, Motor drives- motor efficiency testing, energy efficient motors, motor speed control.4. Lighting- lighting levels, efficient options, fixtures, daylighting, timers, Energy efficient windows.5. Energy conservation in Pumps, Fans (flow control), Compressed Air Systems, Refrigeration & air conditioning systems. Waste heat recovery: recuperators, heat wheels, heat pipes, heat pumps.6. Cogeneration - concept, options (steam/gas turbines/diesel engine based), selection criteria, control strategy. Heat exchanger networking- concept of pinch, target

setting, problem table approach, composite curves. Demand side management. Financing energy conservation

Note: If it runs in the minor slot it will run as EN 410M

EN 218M – Energy Resources, Economics and Environment:

Overview of World Energy Scenario, Dis-aggregation by end-use, by supply Fossil Fuel Reserves - Estimates, Duration Overview of India's Energy Scenario - Dis-aggregation by end-use, by supply, reserves Country Energy Balance Construction - Examples Trends in energy use patterns, energy and development linkage. Energy Economics - Simple Payback Period, Time Value of Money, IRR, NPV, Life Cycle Costing, Cost of Saved Energy , Cost of Energy generated, Examples from energy generation and conservation, Energy Chain, Primary energy analysis Life Cycle Assessment, Net Energy Analysis Environmental Impacts of energy use - Air Pollution - SOx, NOx, CO, particulates Solid and Water Pollution, Formation of pollutants, measurement and controls; sources of emissions, effect of operating and design parameters on emission, control methods, Exhaust emission test, procedures, standards and legislation; environmental audits; Emission factors and inventories Global Warming, CO2 Emissions, Impacts, Mitigation Sustainability, Externalities, Future Energy Systems.

Note: The course used to run as EN 403 but would now run as EN 218M from the spring 2020 semester onwards.

You can choose any courses from this Elective list to complete your last minor course:

1) **EN 613** - Nuclear reactor theory
2) **EN 615** - Wind Energy Conversion system
3) **EN 616** - Direct Energy conversion
4) **EN 617** - Thermodynamic analysis of Industrial Systems
5) **EN 619** - Solar Energy for Industrial Process heat
6) **EN 624** - Conversion of energy in buildings
7) **EN 628** - Materials and for energy conversion devices
8) **EN 630** - Utilisation of solar thermal energy
9) **EN 632** - Waste to Energy
10) **EN 634** - Nuclear reactor thermal Hydraulics and safety
11) **EN 640** - Solar photovoltaics - Fundamentals, technology and application
12) **EN 645** - Process Integration
13) **EN 646** - Energy and climate

NOTE: Any of the other courses offered by the department in addition to the mentioned above could be allowed with permission from Faculty advisor and Energy Science and Engineering HoD

5.10 ENTREPRENEURSHIP

PREFACE:

The Centre aims to support aspiring students in the process of ideation and start-up creation from very early stage. The courses are inter-disciplinary and teams with complementary skills are encouraged. Thus, the courses have a two-pronged approach – academic input and evaluation as per Institute norms and start-up creation which goes beyond the semester boundaries.

All the courses offered by the Centre for Entrepreneurship are open to all the students in all departments from II year up to Ph.D. levels. Thus, all the courses have dual numbering in the 2XX & 6XX series. The courses can be tagged as Minor, Institute Elective or Additional Learning, based on Institute norms for tagging. The ENT Minor is for B.Tech and Dual Degree Students as per Institute norms. All aspects of the start-up creation and operation, right from ideation, team-building, customer discovery and validation, problem definition, product design, prototyping and commercialization are introduced through the courses. If you have an idea or a wish to work on a start-up, the courses provide the right guidance and inputs through the semester and the required handholding later on.

Micro-grants are available for product development under the Proof of Concept Courses and Technology Venture Creation. The grants are provided mainly for efforts towards product design and development and are released as per institute norms after the due approvals.

In addition to the course curriculum, the sessions during all the courses include interactive speaker sessions from entrepreneurs from IITB as well as others.

Autumn Semester Courses – Academic Year 2019-20

The four courses in the Autumn Semester are focussed on the basics so that students get an overview of the start-up life cycle and an understanding of start-up creation. Field work, assignments and a start-up project presentation are mandatory in all the courses. The courses in the Spring Semester are focussed upon definite outcomes from the various classroom exercises.

It is advisable to take the basic courses in the Autumn Semester, before choosing courses in the Spring Semester. While the overall objective is start-up creation, the foundation courses help students get acquainted with the expectations from these courses. However, students may opt for the Spring Semester courses directly.

AUTUMN SEMESTER

ENT 201/603- Introduction to Entrepreneurship (Full Semester Course)

This course provides an overview of the start-up lifecycle right from ideation to customer discovery, validation and Business Model design. The concepts include an introduction to concepts and overview of entrepreneurship, business models and Business Model Canvas, Value Proposition, Marketing, IP, Communication Skills, interactions with entrepreneurs and investors. This course will have the mid-semester and end-semester examination, start-up project and assignments.

ENT 204/606 – Developing a Proof of Concept (Full Semester Course)

This is a project based course and involves workshops in the Lab where you gain hands on experience in fundamental skills required for product development. The expected output is a product designed after learning from the workshops, and concept and product development for your own start-up idea. Both will be evaluated and considered for the overall grade in the course.

EN 207/605 Business Fundamentals for Technology Entrepreneurs (First Half Semester course)

This short course runs like a boot-camp and walks you through the basic business fundamentals that you need to know for your own start-up development. These include inputs in management, sales, marketing, finance, operations, product development, business ethics and communication skills.

ENT 209/607 – Managing Technological Innovation (Second Half-Semester Course)

This course starts after the mid-semester examinations and emphasises on rapid prototyping to prove your concept and product idea. The discipline of innovation, relevant concepts about innovation, technology development, product development etc are introduced through interesting case studies of entrepreneurs from India as well as classroom and lab based activities.

SPRING SEMESTER

Spring Semester Courses – Academic Year 2019-20

Four courses are offered in the Spring Semester. There are similarities in the courses by design however the expected output differs. While an overview of the start-up life cycle and an understanding of start-up creation is given, the rigour is much higher. As in

Autumn Semester courses, field work, assignments and a start-up project presentation are mandatory in all the courses. Credit is given for action taken towards venture creation. Thus, the courses in the Spring Semester are focussed upon definite outcomes from the various classroom exercises.

ENT 208/602- Technology Venture Creation (Full Semester Course)

This course provides an overview of the start-up lifecycle right from ideation to team building, customer discovery, validation, Business Model Canvas, Cost Structure, Financials, Operations, product development, and venture creation. Topics include an introduction to concepts and overview of entrepreneurship, business models and Business Model Canvas, Value Proposition, Marketing, IP, Communication Skills, interactions with entrepreneurs and investors.

Evaluation for this course includes the mid-semester exam and a series of presentations throughout the semester for ongoing understanding of your start-up efforts. It is advisable to have a team and a technology based idea before starting this course. Good for teams working on start-ups to sign up.

ENT 206/608 – Developing a Proof of Concept - Advanced (Full Semester Course)

This is a project based course and involves workshops in the Lab where you gain hands on experience in fundamental business skills required for venture creation. The expected output is a product designed for your own start-up idea. Teams will be evaluated based on the product development efforts during the course.

ENT 210/604 – Marketing for Entrepreneurs (First Half-Semester Course)

This power-packed course is also designed like a boot-camp and provides insights into the nuances of sales and marketing, right from psychological need analysis to social media marketing. Evaluation again is project based, and credit is given towards effort on the ground. The end-semester examination is more a test of your ability to apply the concepts covered rather than a memory test.

ENT 205/601 – Intellectual Property for Entrepreneurs (Second Half-Semester Course)

This course starts after the mid-semester examinations and emphasises on IP awareness. Topics like IP Rights, Types of IP, IP Protection in India and globally are

introduced through some landmark case studies in this domain. Evaluation comprises a quiz, case studies and an end-semester examination.

5.11 ENVIRONMENTAL SCIENCE AND ENGINEERING

PREFACE :

The Centre for Environmental Science and Engineering (CESE) offers wide professional expertise and actively pursues sponsored research, consultancy and technical services. CESE is also very active in manpower development and regularly organizes tailor-made workshops and training programmes. It also offers opportunities for research in environmental protection through pollution control and prevention. Air, Water and Solid Waste issues are related with Chemical Engineering, Mechanical Engineering, Metallurgical Engineering and Material Sciences, Chemistry, Civil Engineering, Energy and Biosciences. This course prepares individuals for careers as engineers and scientists in Environmental Quality & Pollution Control. This program offers coursework and research opportunities leading to the masters and doctoral degrees and ultimately enable our graduates to contribute to the solution of current and future environmental problems.

COURSES:

ES 203 – Water and Wastewater Engineering:

Introduction to water and wastewater technology; water quality and effluent standards; Water

demand forecasting; Determination of reservoir capacity; Water pollution; Environmental hydraulics; Water distribution systems; Wastewater collection; Water and Wastewater treatment: physical, chemical and biological unit operations; Sludge disposal.

ES 204 – Environmental Chemistry:

Aquatic Chemistry, Chemical equilibria and kinetics fundamentals, Acids and bases, Titrations, Acidity, Alkalinity, Buffers and buffer intensity, Chemical equilibrium calculations, pC-pH diagram. Precipitation and dissolution, Water softening and water conditioning, Langelier index, Solubility diagram, Coexistence of phases in equilibrium, Complexation of metal ions and organic complexes in natural water. Oxidation and reduction reactions stoichiometry, Redox couples, pE-pH diagrams, Redox control in natural systems, Basic concepts of organic and colloid chemistry. Soil Chemistry, Weathering reactions, Structure and surface reactions of clays and oxides, Forces at soil-water interfaces. Atmospheric Chemistry, Chemical equilibria and kinetics, Photodissociation and free radical reactions, Chemistry of precipitation, Acid rain.

ES 303 – Municipal Solid and Biomedical Waste Management:

Solid waste management: Sources, Composition and Properties of Municipal Solid Waste, Engineering principles; Generation of solid waste; On Site handling, storage and processing including segregation; Collection of solid waste; Transfer and transport; Processing technique and equipment; Recovery of resources; Conversion products and energy; Composting; Recycling; Incineration and pyrolysis; Disposal of solid waste including sanitary landfill, planning, siting, design, closure and post closure monitoring; Regional/Integrated solid waste management related issues. Biomedical waste : Regulatory framework, categorization; generation, collection, transport, treatment and disposal.

ES 306 – Environmental Systems Modelling :

Definition; Classification; Examples of models for environmental systems. Introduction to air quality models; Meteorology; Atmospheric stability and turbulence; Gaussian plume model and modifications; Numerical models, Urban diffusion models, Calibration and sensitivity analysis; Applications of public domain models and software, Global radiation balance and climatic changes. Transport and fate of pollutants in aquatic systems; Introduction to river, estuarine and lake hydrodynamics; Stratification and eutrophication of lakes; Dissolved oxygen model for streams; Temperature models. Transport and fate of pollutants in soil and groundwater; Utility of environmental models for forecasting. Computational methods in environmental modelling.

ES 401 – Environmental Management:

Environmental regulations and policies; Environmental protection laws and acts; Corporate and international charters and protocols; Environment Risk assessment; Industrial ecology, Pollution prevention and Waste minimization; Sustainable development; Life cycle assessment; Environmental auditing; Eco-labelling of products; Performance indicators. Environmental management systems particularly IS 14000 series. Successful Case Studies.

ES 444 – Industrial Pollution Prevention and Clean Technologies:

Principles and techniques for industrial pollution prevention and waste minimization; Nature and characteristics of industrial wastes; Prevention versus control of industrial pollution; Source reduction tools and techniques: raw material substitution, toxic use reduction and elimination, process modifications and procedural changes; Recycling and reuse; Opportunities and barriers to cleaner technologies; Pollution prevention economics. Waste audits, emission inventories and waste management hierarchy for process industries; Material balance approach; Material and process mapping approach; Emission sources; Estimation of fugitive emissions; Environmental impact of VOCs; Energy and resource (material and water) audits for efficient usage and conservation. Unit operations in separation technology; Pollution prevention for unit operations: Boilers and Heat Exchangers; Storage tanks; Distillation columns; Application of separation technologies for pollution prevention; Process optimization for cleaner industrial processes: Flow Sheet analysis—qualitative and quantitative approaches using mass exchange networks; Thermodynamic constraints to waste minimization; Holistic and critical

technology assessment; Environmental performance indicators; Concept of industrial ecology and symbiosis of eco-parks. Case studies on industrial applications of cleaner technologies in chemical, metallurgical, pulp and paper, textile, electroplating, leather, dairy, cement and other industries.

ES 458 - Environmental Change and Sustainable Development:

Issues of sustainability : food, materials and energy resources, demands, policies, ethics; Paradigms of agricultural/industrial age, population, limits to growth; Current debates on the

issues of sustainability; Relationships of ecological, economic and social systems; Engineering tools for assessment and design for environment and sustainability; Relevance of traditional paradigms for rural India.

NOTE: ES 444 and ES 458 is offered in alternate years

5.12 HUMANITIES AND SOCIAL SCIENCES

PREFACE:

The Department of Humanities and Social Sciences plays a unique and distinctive role in an institute where the ethos of science and technology prevails. It is believed that engineering and science are, by their very nature, humanistic and socially derived enterprises. Hence a complete science and technology education must include liberal arts, economics, social and behavioural sciences where the students unites application of scientific principles along with human, moral and social understanding. The undergraduate courses taught by the Department faculty aim at making the science and technology students aware of the various issues concerning man and society. They are meant to sensitize students to the broader social, cultural, economic, ethical and humane issues involved in social change.

The course content of HSS minor courses are highly instructor dependant for many courses and they generally run a subset of courses from the following pool:

HS 207: Social Psychology
HS 208: Approaches to Literature
HS 213: Language and Literature
HS 215: Quantitative methods for Economic analysis
HS 217: Sociological Theory
HS 219: Applying Psychology in Modern Life
HS 411: Indian Economy
HS 412: Social Movement and Social Change: Contemporary change: Contemporary Reflections

HS 417: Philosophy of Life

Course Content

Philosophical examination of the basic concepts concerning life, death, and nature, The meaning and demeaning of life, difference between 'life' and 'existence', human nature, self, life and ownership, nature of morality, value and happiness, social security, relationship and irreplaceability, human freedom, abortion, euthanasia, the rights of the terminally ill, and the possibility of life after death.

Different philosophical approaches to the meaning of life would be discussed. Indian perspectives: Charvaka; Advaita Vedanta; Bhagavad Gita; Buddhism Western perspectives: Aristotelian; Kantian; Existentialist; Analytical

HS 419: Methodological foundations of Indian scientific tradition

Course Content

Vyakarana: Structure of Sanskrit language Formation of words (sabdanis.patti) - Phonology (sabdotpatti) ` Primary aphorisms (sutras) ` Secondary rules/Notes on aphorisms (vartika) ` Paribhas.a and domain of application of rules.

Nyaya - Vaisesika: Classification of substances ` Characteristics of definition (Laksanalaksanam) ` The notion of absence (abhava) ` J`nana or cognition, Anumana of inference. The concept of (Vyapti) or invariable concomitance ` the combination of deductive and inductive reasoning ` Hetvabhasa or been vitiated inference.

Epistemology: Pramana of means of valid knowledge ` issues related to redundancies ` Validity of knowledge ` its nature with reference to the origin (utpatti) and with reference to its cognition (j`napti) ` Theories explaining the concept of illusory cognition (khyativada) ` Use of avacchedaka, vi`sesyata, prakarata and so on to achieve precision in definition.

HS 426: Theory and Policy of Managerial Finance

Course Content

Introduction to financial statements. Concepts of compounding and discounting, Valuation of securities.

Sources of finance - Trade credit. Bank finance. Term finance. Stock market. Dividend policy. Share valuation. Leverages. Theories of capital structure. Cost of capital.

Capital budgeting. Cash flow analysis. Methods of depreciation. Methods of capital appraisal. Risk and uncertainty in capital budgeting.

Introduction to working capital management. Issues in financial planning. Tax planning. Break-even analysis. International aspects of financial management. Foreign exchange Market. Exchange rates. Currency risks etc.

HS 457: Managerial Economics

Course Content

Nature and scope of Managerial Decisions. Objectives of firms. Techniques of analyses with special reference to econometric method. Analysis of demand pattern - demand forecasting. Production function and production planning - cost and product relationships cost function. Break-even-point analysis. Pricing and price related policies. Labour productivities and wages. Optimization problems. Introductory aspects of capital budgeting. Selected case studies under Indian conditions.

HS 465: Moral and Political Philosophy

Course Content

Ethics and Politics.

The State-Power and Authority; Natural Law and Natural Rights; Liberty, Equality, Justice; Sovereignty, Political Obligation; Law and Morality; Punishment; Democracy.

Anarchism; Individualism; Conservatism; Utilitarianism; Radical Humanism; Socialism; Liberalism & Communism; Civil Disobedience; Social Progress; Revolution; Terrorism and Militancy; Ethnicity, Peace and Conflict; Patriotism; Sarvodaya.

HS- 467: Indian Philosophy

Course Content

A study and examination of the logical, epistemological and ethical problems in the classical schools of Indian Philosophy, science and metaphysics in ancient India. The course will emphasize the insights of ancient Indian thinkers and their perennial preoccupation with issues centering on man and his being in the world in society.

HS 474: Postmodernism and Philosophy

Course Content

Enlightenment reason and its fragile interior: Validity claims and normative action, immanent and transcendent sources of realism and its critique through Kant, Nietzsche, Foucault and Deleuze.

Derrida`s radical critique of knowledge: Deconstruction, Singularity and Alterity, Identity, Erasure; Subjectivity and Responsibility .in Emmanuel Levinas and Derrida. Recovering the text and meaning: Communicative action of Habermas, Honneth's Critique of power, Lyotard's Report on Knowledge.

Indeterminacy of meanings: Pragmatism of Richard Rorty, Internal realism of Hilary Putnam and belief revision in David Lewis. After the subject: Otherness in Helen Cixous, Femininity in Luce Irigaray, Presence in Jean Luc Nancy.

Critiquing natural and human sciences: science as Praxis, Phenomenology of natural sciences, The neo-Heideggerian critique of science as a critical enterprise. Postpositivism and critical realism: Satya P. Mohanty and Roy Bhaskar.

HS-490: Organizational Behaviour and Implications for Management

Course Content

This course is designed for the final year engineering students. It has four interrelated goals. The first is to make the prospective engineers familiar with the basic concepts of organizational behaviour. Second is to introduce the management and behaviour sciences theories along with their application for managing people at work. The third is to introduce major components of American and Japanese management. Finally, an attempt will be made to critically examine all management strategies of organizational behaviour in reference to Indian organizations. The course will be of help in applying engineering knowledge more effectively in the field of business management and entrepreneurship development.

You can find sample course contents for the above: asc.iitb.ac.in or http://www.hss.iitb.ac.in/en/btech

5.13 INDUSTRIAL DESIGN CENTRE

PREFACE:

Design at IDC is all encompassing, coexists in an active triadic relationship with design education, design research and design practice. Design education - to train and propagate; design research - to seek, analyse, experiment, integrate; and design practice to apply, implement and realize. IDC strives towards creating an excellent pedagogical environment with foundations in these areas to prepare professionals and visionaries of tomorrow. The following courses are run by the department towards the award of a minor degree. Only a few courses of these run each semester.

AUTUMN SEMESTER

DE 403 Studio Project I

The studio project is offered for students who already have exceptional skills in the area of design and are able to contribute to the specialisation of the faculty. The student will have to undertake a topic in guidance with the guide from IDC and would have to complete the project within the semester.

DE 405 Studio Project II

The studio project is offered for students who already have exceptional skills in the area of design and are able to contribute to the specialisation of the faculty. The student will have to undertake a topic in guidance with the guide from IDC and would have to complete the project within the semester.

DE 407 Technology and Animation

The course is an eye opener to how various technologies have influenced the methods and workflow in animation & how use of animation has affected technology. This includes A historical perspective of technology in animation. Digital Image & Video Input technologies Digital Image Processing Visual Database creation & Management for animation Virtual 3D world creation & Rendering Expressions, Relationships computation and solving and their applications Mechanical Rigs and Gizmos for animation & effects. Motion Capture & Motion Control Convergence and combination of different sources for animation & effects creation Use of Animation in Technology & Science. New frontiers with the combination of Science, Technology & Animation Interactivity, optimisation, real-time animation. Massive parallel processing & distributed rendering.

DE 414 Innovation By Design

In a world full of challenges and problems that need to be urgently addressed, innovation is what makes it possible to come up with solutions that will benefit the maximum number of users. And such, innovation is often enabled by design. The MOOC 'Innovation by Design' familiarizes students with the concept of innovation. It traces the journey of a design idea from the identification of a problem to a final solution that has a positive impact on a large group of users. Through case studies that focus on the "seven concerns of innovation", the course shows how the innovation process requires empathy, meticulous effort, constant user interaction and effective collaboration.

This course has eight modules. The first module is an introduction to the seven concerns of innovation: the cause, the context, the comprehension, the check, the conception, the crafting and the connection. Each of the seven concerns is taken up for detailed discussion in modules two to eight. The course emphasizes the iterative nature of the innovation process and points out why ideas often fail when they encounter pitfalls at critical points in this process. The course also acquaints students with the 'collaborative model of innovation', a concept that captures the kind of teamwork and collaborative effort required at each stage of the design journey.

DE 415 Understanding Design

We are surrounded by designed objects, from highways that traverse thousands of kilometers to a pen drive that fits a lot in the smallest of spaces. Designers have used their skills to translate ideas and needs into all the objects that we see around us. Design can be interpreted in multiple ways and can mean different things in different contexts. This course aims to create an awareness and understanding of the discipline of design and its multidisciplinary nature. The relevance and value of design and how it impacts society, industry and the environment is established through lectures, case studies and project activities.This course is for those who are curious to understand what design is and why it is important.

DE 401 Basics of Visual Communication

Visual communication is communication through visual aid and is described as the conveyance of ideas and information in forms that can be read or looked upon. Visual

communication in part or whole relies on vision, and is primarily presented or expressed with two dimensional images, it includes: signs, typography, drawing, graphic design, illustration, Industrial Design, Advertising, Animation colour and electronic resources. It also explores the idea that a visual message accompanying text has a greater power to inform, educate or persuade a person or audience.

DE 409 Introduction to Ergonomics

What is ERGONOMICS, History, MAN-Machine-ENVIRONMENT system, Body Dimensions and usage. Furniture/Office ergonomics, Occupational health and safety, Impact of physical environment on human body, Case Studies.

DE 411 Design Issues

This course is to expose the students to different thoughts and perspectives on design. The course will present different concerns and issues in the context of design. The course will also expose the students to emerging areas of design. Relevance of design in the context of India. Importance of sustainable design practices. Preserving traditional practices. Designing for the underserved communities. Exposure to bionics, nano design, experience design, green design, etc.

DE 413 Introduction to Scriptwriting

Script and story structure, plot and scenario building, character development, dialogue writing, visual treatment, scripting formats, writing for animation and live-action.

SPRING SEMESTER

DE 402 – Introduction to Design:

History of industrial design, The significance and value of industrial design, Basic characteristics of industrial design, The wide spectrum of design practice and terminology, Industrial design methodology, Creation of a product, Factors concerning the product in use, Capturing insights of users, Creative idea generation, From generation of products, Design for manufacture, Appearance of the product, Case studies on wide variety of products to showcase the above.

DE 404 – Basics of Animation:

The concept of animation, Persistence of vision, Broad methods in traditional animation, Computer animation, Effects and integration with live action, Stop motion animation, Other methods in animation, pixilation, animatronics, the principles of animation. From story to script to screen, pre–production, production and post-production, the process applications if animations of films, episodes, commercials, visualisation, simulation, online, education, gaming and mobile technology.

DE 403 Studio Project I:

The studio project is offered for students who already have exceptional skills in the area of design and are able to contribute to the specialisation of the faculty. The student will have to undertake a topic in guidance with the guide from IDC and would have to complete the project within the semester.

DE 405 Studio Project II:
The studio project is offered for students who already have exceptional skills in the area of design and are able to contribute to the specialisation of the faculty. The student will have to undertake a topic in guidance with the guide from IDC and would have to complete the project within one semester.

DE 408 Elements of Design I:

- An introduction to basic elements: Line, texture, colour, form, symmetry, balance, scale, mass, unity and variety.
- Concept of visual language and visual design.
- Introduction to Gestalt laws, composition and figure and ground relationships. Introduction to the concept of negative space.
- Use of symmetry. Generation of patterns and textures using simple elements.
- Introduction to typography and fonts.
- Use of grids in graphic composition.
- Colour circle, colour combinations and its dimensions: hue, value and chroma.
- Colour meanings in traditions and psychological use of colours.
- For detailed course contents contact the IDC departmental office or the instructor taking it in that semester.

DE 410 Perspectives on World Cinema

An overview of Film History Social Context of Filmmaking

Relationships of Filmmakers to their milieu. Analysis of Selected Classics of Cinema. Common themes and individuals styles, similarities and contrasts in styles Asian Cinema. Film directors Akira Kurosawa, Mizoguchi and Kiarostami.

European Cinema: Film Directors Godard, Truffaut, Bergman and Fellini

Russian Cinema:film director Andrei Tarkovsky

Ameriacn Cinema: Film directors Sidney Lumet and Stanley Kubrick. Writing of a film diary of required film viewing. A long form essay on any filmmaker would be a final requirement for completion of the course

5.14 INDUSTRIAL ENGINEERING AND OPERATIONS RESEARCH

For the newly launched minor programme from the IEOR department, **you need to complete IE 501 and 502 and one of IE 503 or 504.** The remaining two courses should be IE labelled

Electives. It is suggested that the students complete IE501, IE502 and IE503 or IE504 before choosing any other IE labelled Electives. IE labelled electives can be any two IE labelled theory courses (subject to the satisfaction of pre-requisite requirements, as applicable), but excluding IE 505, IE 507, IE 605, IE 614, IE 684.

COURSES (TENTATIVE) IN AUTUMN SEMESTER (JUL-NOV 2018):

IE 501 - Optimization Models:

Prerequisite: Instructor's permission

Modeling of allocation and control problems in industry and social systems. Framework and overview of optimization with examples of continuous and discrete optimization, unconstrained and constrained problems. Single stage and multi stage models. Formulations and equivalences. Examples from science, engineering and business. Linear programming. Geometry and algebra of the simplex method. Duality & sensitivity. Combinatorial optimization problems with emphasis on applications, notion of large feasible spaces and neighborhood solutions, representation of solution space, search tree, search techniques, branch and bound method. Examples of mixed-integer programming models. Use of binary variables in constraint modeling. Decision problems involving network flows, assignment models, transportation models, multi-stage flows.

IE 503 - Operations Analysis:

Prerequisite: Instructor's permission

The aim of the course is to familiarize students with supply chain system and issues therein; and equipped with techniques to model some specific operational issues in such systems.

Part 1: Stages of manufacturing supply chain and value addition. Concepts of supply, storage, production, warehousing and transport. Supply chain terminology. Structure of supply chains, decisions and decision levels in the supply chain. Overview of supply chain operations & costs: location, procurement, production, inventory, transportation, and information technology. Material flow systems: push, pull, flow shop, job shop, cell, etc.

Part 2: Quantitative models in supply chain systems including forecasting, production planning, scheduling and inventory models. Basic forecasting models. Product structure representation.

Bill of materials. Material accounting logic and MRP systems. Scheduling and sequencing of parts: single/two machine. Notion of quality & quality control. Quality and yield of manufacturing processes. Inventory models: EOQ, periodic review, continuous review. Introduction to procurement and distribution models. Transport & logistics costs. Project management techniques: CPM and PERT.

IE 601- Optimization Techniques: (8 CREDITS)

Prerequisite: Exposure to relevant concepts at undergraduate level and instructor consent

The aim of this course is to have some basic understanding of provably convergent computational schemes for R^n constrained optimization problems. Some examples, mainly from decision making viewpoint. A brisk look at linear programming: Fundamental theorem of linear programming, Degenerate solutions, Simplex based methods, Cycling, Duality, Complementary slackness conditions.

Nonlinear programming: First and second order conditions. Iterative methods and associated issues. Line search methods: Stationarity of limit points of steepest descent, successive step-size reduction algorithms, etc. Hessian based algorithms: Newton, Conjugate directions and Quasi-Newton methods.

Constrained optimization problems: Lagrange variables, Karush-Kuhn-Tucker conditions, Regular points, Sensitivity analysis. Quadratic programming, Convex problems. Optional Topics: Mixed integer models; Interior point methods; Iterative schemes for constrained problems; Sequential quadratic programming methods; Barrier methods; Trust-region methods, etc.

IE 611- Introduction to Stochastic Models: (8 CREDITS)

Prerequisite:Exposure to relevant concepts at undergraduate level and instructor consent

Apart from their intrinsic role in the theory of stochastic processes, Markov chains and regenerative processes form an important set of tools for analysis and optimization problems arising in many decision models. A quick review of calculus based probability: Random variables, joint and marginal laws, conditional expectation. Stochastic processes, notion of sample paths, finite dimensional distribution functions, Kolmogorov's consistency theorem. Time averages and laws of large numbers.

Discrete time countable state Markov chains, definitions and characterizations, hitting times, first step analysis, stopping times and strong Markov property. Recurrence and transience. Communicating classes, invariant measures for irreducible chains, positive recurrent chains, ergodic theorem. Periodic chains, convergence in variation and coupling lemma. Absorption

probabilities and criterion for transience. Discrete time renewal theory, elementary renewal and renewal reward theorems. Regenerative processes and their time averages.

Jump processes; jump chain and sojourn time construction of continuous time MCs, Poisson processes, birth-death processes. Forward and backward equations. Class structure, recurrence and transience, invariant distributions, convergence to equilibrium. Uniformization and time reversed chains. Optional topics: Conditional expectation and conditional measures, Markov processes, Brownian motion, diffusions, Martingales, etc.

IE 603- Discrete Event System Simulation:

Concepts in discrete event system simulation; approaches based on event scheduling, process interaction and activity scanning. Examples of systems such as job shop scheduling & extensions, queuing systems, inventory systems. Use of linked lists in implementing some common data structures encountered in simulation. Simulation in C. Concepts of object oriented simulation. Simulation packages. Overview of basic concepts from probability and statistics concerning random variables, correlation, estimation, confidence intervals, hypothesis testing. Generation and testing of random numbers. Generation of random variates, random vectors, correlated random variates and stochastic processes. Input modeling; useful probability distributions; hypothesizing families of distributions, estimation of parameters, testing goodness of fit. Simulation Output data analysis for a single system; statistical analyses for transient systems and systems in statistical equilibrium. Comparing alternative system configurations; confidence intervals, ranking and selection. Variance reduction techniques. Experimental design, sensitivity analysis and optimization. Simulation of manufacturing systems.

IE 605: Engineering Statistics

Prerequisite: Exposure to relevant concepts at undergraduate level and instructor consent

Course Content

The course provides a strong foundation in theory and methods of modeling randomness and data analysis in engineering applications. Specific topics include, review of calculus-based probability concepts, common distributions, expectation, moment generating functions; sampling statistics, order statistics, properties of sample mean, Central Limit Theorem. Sampling from a Normal distribution; Parameter estimation, maximum likelihood estimators, interval estimates; bias, efficiency and consistency of point estimators; sampling plans, sequential tests, Hypothesis testing, common tests concerning means, variances, goodness-of-fit, likelihood ratio test, Neyman-Pearson lemma; Regression models, design of experiments.

IE 612- Introduction to Financial Engineering:

Prerequisite: Exposure to relevant concepts at undergraduate level and instructor consent.

The only requirement for this course is that either you are doing IE 611 (or equivalent) along with course or have already done such a course. Probability background is not required in the first half, but you require it for the second half of the course.

The aim of this course is to cover some basic concepts of financial engineering: the issues that arise in modeling, analysis and decision making involving financial instruments. Discrete time models and computational tools will be the focus.

Portfolio optimization: Markowitz model; Two and one fund theorems; mutual funds. Capital Asset Pricing model; Security market line.

Arbitrage; Hedging; Pricing. Contingent claims; Forward and futures contracts. European and American options; Asian and other path dependent options. One and multi-period binomial models; Finite state models. Equivalent martingale measures; Completeness of markets; Fundamental asset pricing theorems; Option pricing. Black-Scholes option pricing formula.

Note: this course might not be offered in the autumn semester for academic year 2019-20

IE 643- Deep Learning - Theory and Practice

Course Content:

The Perceptron, Feed-forward networks and Multi-layer perceptron, Memory based networks like Boltzmann Machines, Hopfield Networks. State based networks like Recurrent Neural Networks, Long Short Term Memory Networks. Convolutional Neural Networks, Bidirectional networks, Concept based networks used for transfer learning, Structural Networks for structured prediction, Attention based networks, Auto encoders for dimension reduction and embedding, Generative Adversarial Networks, Deep Gaussian Processes, Deep Bayesian nets, Deep Search Models, Deep Reinforcement Learning, Deep Neural Recommenders. Non-convex Optimization tools for Deep Networks. Theoretical tools to describe Convolutional Neural Networks and Recurrent Neural Networks. Learning theory for Deep Neural Networks. Several Applications covering operations research, computer vision, natural language processing, multimedia analytics, proof checking. .

IE 714: Quantitative models for supply chain management

Prerequisite: IE 601 and IE 611, or equivalent or Instructor's permission

Supply chain management involves a number of decisions that benefit by quantitative techniques of analysis and design. The course will take up a few of these to explore modeling, computation and IT-enabled implementation of solutions in some areas of Supply Chain Management. The application areas include material flow management across the supply chain,

value management and analysis of total supply chain costs, robust design of supply chains, coordination of supply chain decisions and handling of uncertainties in supply chain management. The emphasis will be on modeling, analysis and implementation issues, including a few case studies, but the relevant techniques will be covered as required.

Note: This course might be discontinued from autumn semester 2019-20

COURSES IN SPRING SEMESTER (JAN-MAY 2019):

IE 502 - Probabilistic Models:

Prerequisite: Instructor's permission

Models and techniques to deal with randomness that underlie many industrial and social systems. It includes discussions on models, their properties and their applications. Review of basic probability concepts: conditional probability and random variables. Stochastic processes, sample paths, finite dimensional distribution functions. Time averages and Laws of large numbers. Finite state Markov chains, Chapman-Kolmogorov equations, limiting state probabilities, Stationary distributions. Memory-less property of exponential random variables and related models & examples. Poisson process and its applications. Renewal processes with examples. Elementary Queueing theory: steady state probabilities, Little's Law. Exponential models with examples. Applications of open and closed queueing systems. Applications in reliability theory, systems with parallel and series of components, component life vs. system life, expected system life. Applications in inventory, random demand and stockouts, notions of service levels. Performance measures of above models in terms of relevant transient and steady state Distributions.

IE 504 - Service & Infrastructure Systems:

Prerequisite: Instructor's permission

This course aims to familiarize students with service & infrastructure systems, and related issues of allocation and deployment of various resources and to introduce techniques to model some planning and operational issues in such systems.

Part 1: Introduction to service systems in the economy, banks, hotels, maintenance centres, call centres, hospitals, emergency services, etc. Basic features of technology and operation of service systems. Measures of performance. Examples of infrastructure systems in the economy. Transport: Road, rail, water and air transport systems. Non motorised transport. Telecommunication systems. Power generation and distribution systems. Common principles of planning capacity and service delivery.

Part 2: Capacity planning for service systems. Modeling of demand for services. Service time modeling. Service performance measures. Planning of service facilities. Crew and personnel

planning. Planning of infrastructure systems. Fixed costs, sunk costs and variable costs of infrastructure. Break even analysis. Introduction to financing and operating of infrastructure systems. Facility location models. Minimum cost models. p-median and p-centre problems. Concepts of system and user equilibria. Role of pricing in long term use and operation of infrastructure. Introduction to pricing in telecom and transport services. Demand management in energy and power sectors. Peak load and time of use pricing models.

IE 618: Advanced Stochastic Processes for Operations Research

Prerequisites: IE 611 or equivalent and Instructor's consent.

Course contents

Construction of Probability Measure, Integration, Convergence theorems, Law of large numbers and Central limit theorem. Lp spaces and Conditional expectation. Martingales : Super and Sub martingales, Doob's inequalities, Martingale convergence theorems. Analysis of M/G/1 and GI/M/1 queues. Derivation of Little's law and PASTA. Markov chains and stability (general state space, e.g., Rn): Introduction, \psi-irreducibility, Small sets, Transience and Recurrence. Drift criterion, SLLN, CLT. Random Walk Models, Analysis of G/G/1 queues using Ladder chains.

TENTATIVE LIST OF REST OF THE SPRING SEMESTER COURSES WILL BE RELEASED IN AUGUST

ADDITIONAL COURSES THAT WERE THERE IN LAST SPRING SEMESTER:

IE 613 Online Learning
IE 616 Decision Analysis and Game Theory
IE 645 Industrial Scheduling
IE 708 Markov Decision Processes
IE 709 IEOR for Health Care
IE 710 OR Applications in Infrastructural and Service Sectors
IE 712 Selected Application of Stochastic Models

5.15 MANAGEMENT

PREFACE:
Management comprises of diverse set of fields where every field aims to take a step in the direction such that it will help the individual in controlling business organisations so that they can perform at their efficient levels and constantly develop in their field.

Other Benefits:

The Management minor plays a very important role for a person who aims at a career in general management industry or government. It gives a basic taste of management to a person in case he or she opts for an MBA.

COURSES:

MG 401 – Marketing Management:

Principles of Marketing (4 P's and 5 C's). Sales and Demand Forecasting. Marketing Strategy and tactics. Marketing analysis. Organization`s system for planning the marketing effort. Implementation of marketing strategies. Analysis of practical marketing problems.

MG 402 – Human Resource Management:

Personnel Management vs Human Resource Management. Principles of HRM. Who is a Manager and his responsibilities? What is Human Resource Planning and Staffing? Organisational Structure and Culture. Leadership. Stakeholders, Managers and Ethics Recruitment & Training. Performance Management & Appraisal

MG 403 – Basics of Accounting and Financial Management:

Principles of Accounting, Double Entry System, Assets, Liabilities, Reserves, Shareholding patterns, discounted cash flows, Net present value of money, financial case studies, Tax Savings.

MG 405 – Project Management:

Project management Process and role of Project Manager. Project screening and Selection Techniques Structuring concepts and Tools (WBS, OBS, and LRC). Project Planning Tools (Bar charts, LOB, CPM, and PERT). Cost Estimates and Estimating Methods, Project Budgeting. Project Planning and Scheduling, Project Scheduling with Resource. Constraints, Resource Levelling and Allocation. Case studies on managing special projects (Software projects /New Product Development projects/ R&D projects /Mega Projects).

MG 406 – Operations Management:

Principles of Operations Management. Practices in Operations Management. Inventory Management. Supply Chain Design. Planning and Controlling Supply Chain Scheduling. Continuous and Batch Processes. Quality Management.

MG 407 - Strategic Management

Industry Structure, Concept of Corporate and Competitive Strategies Generic Strategies Strategic Options – New Product / New Market development, Diversification, Strategic Alliances, Innovation, Mergers and Acquisitions, Turnaround strategy Measures of Performance and control CSR as a Strategic Initiative Corporate Governance

5.16 MATHEMATICS

The minor programme in Mathematics is designed to allow engineering and science students to pursue a more rigorous education in mathematics. The minor courses have been selected to represent the different basic areas of mathematics. A student completing these courses will achieve a better understanding of the mathematical techniques used in the sciences and engineering disciplines and will also be well equipped for further advanced mathematical education.

Other benefits:

Having a good understanding of Maths Concepts helps you develop a more analytical approach in general. The exercises of so many different concepts are like exercises for your mental health. Maths Minor helps you develop a better attitude of questioning why things are the way they are? It helps you not to take things for granted. You start thinking and analysing what other possibilities made sense in a given situation and how to support your intuition via rigorous arguments. These habits that develop along with some serious understanding of mathematics provide you a heads up in comparison to others. You can read and understand any maths related research paper or papers that need some related concepts. Besides this, certain companies appreciate someone who has a good understanding of Maths during placements.

MA 403 – Real Analysis:

Review of basic concepts of real numbers: Archimedean property, Completeness.Metric spaces, compactness, connectedness, (with emphasis on Rn).Continuity and uniform continuity.Monotonic functions, Functions of bounded variation; Absolutely continuous functions. Derivatives of functions and Taylor`s theorem. Riemann integral and its properties, characterization of Riemann integrable functions. Improper integrals, Gamma functions.Sequences and series of functions, uniform convergence and its relation to continuity, differentiation and integration. Fourier series, pointwise convergence, Fejer's theorem, Weierstrass approximation theorem.

MA 419 – Basic Algebra:

Review of basics: Equivalence relations and partitions, Division algorithm for integers, primes, unique factorization, congruences, Chinese Remainder Theorem, Euler ϕ-function.Permutations, sign of a permutation, inversions, cycles and transpositions. Rudiments of rings and fields, elementary properties, polynomials in one and several variables, divisibility, irreducible polynomials, Division algorithm, Remainder Theorem, Factor Theorem, Rational Zeros Theorem, Relation between the roots and coefficients, Newton's Theorem on symmetric functions, Newton's identities, Fundamental Theorem of Algebra, Rational functions,

partial fraction decomposition, unique factorization of polynomials in several variables, Resultants and discriminants. Groups, subgroups and factor groups, Lagrange's Theorem, homomorphisms, normal subgroups. Quotients of groups, Basic examples of groups: symmetric groups, matrix groups, group of rigid motions of the plane and finite groups of motions. Cyclic groups, generators and relations, Cayley's Theorem, group actions, Sylow Theorems. Direct products, Structure Theorem for finite abelian groups.Simple groups and solvable groups, nilpotent groups, simplicity of alternating groups, composition series, Jordan-Holder Theorem. Semidirect products. Free groups, free abelian groups. Rings, Examples (including polynomial rings, formal power series rings, matrix rings and group rings), ideals, prime and maximal ideals, rings of fractions, Chinese Remainder Theorem for pairwise comaximal ideals. Euclidean Domains, Principal Ideal Domains and Unique Factorization Domains. Polynomial rings over UFD`s

MA 406 – General Topology:

open sets, closed sets, neighbourhoods, bases, sub bases, limit points, closures, interiors, continuous functions, homeomorphisms. Examples of topological spaces: subspace topology, product topology, metric topology, order topology. Quotient Topology: Construction of cylinder, cone, Moebius band, torus, etc. Connectedness and Compactness: Connected spaces, Connected subspaces of the real line, Components and local connectedness, Compact spaces, Heine-Borel Theorem, Local -compactness. Separation Axioms: Hausdorff spaces, Regularity, Complete Regularity, Normality, Urysohn Lemma, Tychonoff embedding and Urysohn Metrization Theorem, Tietze Extension Theorem. Tychnoff Theorem, One-point Compactification.Complete metric spaces and function spaces, Characterization of compact metric spaces, equicontinuity, Ascoli-Arzela Theorem, Baire Category Theorem. Applications: space filling curve, nowhere differentiable continuous function. Optional Topics: Topological Groups and orbit spaces, Paracompactness and partition of unity, Stone-Cech Compactification, Nets and filters.

MA 412 – Complex Analysis:

Complex numbers and the point at infinity. Analytic functions. Cauchy-Riemann conditions. Mappings by elementary functions. Riemann surfaces. Conformal mappings. Contour integrals. Cauchy-Goursat Theorem. Uniform convergence of sequences and series. Taylor and Laurent series. Isolated singularities and residues. Evaluation of real integrals. Zeroes and poles, Maximum Modulus Principle, Argument Principle. Rouche's theorem.

MA 522 – Fourier Analysis and Applications:

Properties and Uniqueness of Fourier Series. Convolutions, Cesaro and Abel Summability. Fejer's theorem, Poisson Kernel and Dirichlet problem in the unit disc. Mean square Convergence, example of Continuous functions with divergent Fourier series. Distributions and Fourier Transforms. Calculus of Distributions, Schwartz class of rapidly decreasing functions.

Fourier transforms of rapidly decreasing functions. Riemann Lebesgue lemma, Fourier Inversion Theorem, Fourier transforms of Gaussians. Tempered Distributions. Applications to PDEs (Laplace, Heat and Wave Equations). Schrodinger-Equation and Uncertainty principle. Paley-Wiener Theorems, Poisson Summation Formula: Radial Fourier transforms and Bessel functions. Hermite functions.

5.17 MECHANICAL ENGINEERING

PREFACE:

The minor in mechanical engineering complementary studies in a major field closely allied to mechanical engineering, such as materials science and engineering, aerospace engineering, electrical engineering, civil engineering, chemical engineering and a number of other possibilities. A student can be awarded a minor in mechanical engineering provided he/she completes courses worth 30 credits (typically 5 courses) out of the following courses:

COURSES:

ME 201 – Solid Mechanics (6 credits):

Fundamentals of mechanics of deformable solids – Introduction, analysis of axial and shear loaded components, Castigliano's theorem, Beams – shear force and bending moment diagrams, Stress, strain, and their relationships, Thermal stress, Mohr's circle, Stresses in beams, Torsion.

ME 209 – Thermodynamics (6 credits):

Systems: Interaction with surroundings, properties, classification, Equilibrium, Units and dimensions, Conversion factors, Work: Thermodynamic definition and characteristics, Adiabatic systems and processes, First Law of Thermodynamics, Zeroth law of Thermodynamics, Empirical temperature and Principles of Thermometry, Ideal gas approximation, equation of state, Van der Waals Gas Equation, Properties of steam, steam tables, Open systems and application of First Law: General form and special cases, Second Law of Thermodynamics: Kelvin-Planck and Clausius statements, Carnot theorem, Carnot engine, Thermodynamic Kelvin scale, Clausius inequality and entropy: principle and evaluation, Second law for closed and open systems, Availability and Exergy.

ME 219 – Fluid Mechanics (8 credits):

Fluid Mechanics will give you a very broad idea of fluid statics and dynamics and equip you with a first-hand analysis to compute basic flow parameters. Introduction: fluid characteristics, continuum concept and properties of fluids, Fluid statics and kinematics, Flow analysis using the

Control Volume approach, Navier-Stokes equations and solutions to some special cases, Boundary layer theory, Dimensional analysis, Introduction to Compressible Fluid Mechanics.

ME 316 – Kinematics and Dynamics of Machines (6 credits):

The course is divided into two major sections. One involves study of the kinematics of mechanisms, and the other involves study of dynamics of machinery. The kinematics part involves: Degrees of freedom, types of joints and motions, Different types of linkages, their uses and inversions, 4 bar linkage: displacement, velocity and acceleration (analytical technique), Graphical techniques for kinematics, Cam motions: Principle, standard cam-follower motion design. The dynamics part involves: Dynamic (force) analysis of 4 bar linkage, slider crank mechanism, Introduction to vibration theory and resonance of structures.

ME 333 – Manufacturing Processes I (6 credits):

Manufacturing Introduction: Materials, processes, Metal Casting: Types, tooling design, solidification, feeder design, mold filling, gating design, simulation, defects, Welding and Brazing: Types, analysis and defects, Metal Forming Processes: Rolling, forging, bending, drawing, extrusion.

ME 338 – Manufacturing Processes II (6 credits):

Material Removal Processes: Mechanics of Machining, tool geometry and materials, chip formation, tool temperature, tool wear, tool life, surface finish, machinability, Optimization of machining processes, Machine Tools: Generation of surfaces by machining, basic operations on shaping, slotting and planing machines, lathe, drilling and boring machines and grinding machines, Process Parameters and setups, Production Machines: Capstan and turret lathes, automats, broaching machines, centreless grinding machines, Special purpose machines for thread cutting and gear cutting (hobbing and shaping), Finishing processes: honing, lapping, burnishing and deburring, Introduction to modern machining processes: EDM, ECM, LASER, Jigs and fixtures: principles of location and clamping, synthesis of simple jigs and fixtures.

5.18 PHYSICS

Preface:

The minor elective courses include courses needed for a basic understanding of physics as it is taught in a Master's programme today. In addition, there are also courses that are designed to expose students to modern areas of research in physics, and to equip them with the theoretical knowledge required to further appreciate the application of physics in their own fields.

COURSES:

PH 252 – Introduction to Quantum Mechanics(EP 252):

(Compulsory)

Basic Ideas and Origin of Quantum Mechanics, Various Experiments, which led to the birth of Quantum Mechanics, Wave Particle Duality Schrodinger Equation and Interpretation of Wave functions, Elementary Ideas of Operators, Eigenvalue problem, Various boundary value Problems, Bound States, Harmonic Oscillator problem (1-dimension), Derivation of Hermite polynomial. Creation and Annihilation Operators, Higher Dimensional Problems, Degeneracy, Hydrogen atom problem in some detail, Many Body Theory , Going beyond Hydrogen atom problem(Helium, Lithium), Many Body Hamiltonian, Born -Oppenheimer Approximation, Tight - binding Approximations, Few simple problems, Introduction to Hartree and Hartree-Fock Theory. Perturbation Theory (Time independent), Derivation of 1st order and 2nd order correction to Eigen energy and eigenstate, Various Problems.

PH 253 – Thermal and Statistical Physics(EP 322):

(*Compulsory)*

A brief recap of thermodynamics followed by the statistical approach to it and the explanation of its applications and resulting phenomena. Course contents: Review of thermodynamics: notion of equilibrium, equation of state, first and second laws of thermodynamics, thermodynamic potentials and Maxwell`s relations. Phase space, ergodicity, Liouville's theorem, microcanonical, canonical and grand canonical ensembles, Boltzmann statistics and its applications to ideal gas. Bose-Einstein and Fermi-Dirac statistics, and their applications.

PH 352– Condensed Matter Physics(PH 432):

It deals with the physical properties of condensed phases of matter. Condensed matter physicists seek to understand the behaviour of these phases by using physical laws. Course contents: Crystal structures, reciprocal lattice, X-ray and electron diffraction. Lattice vibrations, Einstein and Debye models, phonons, Drude and Sommerfeld models, Block theorem, Empty lattice and nearly free electron model, tight-binding model, Density of states and Fermi surfaces. Semi classical model of electron dynamics. Concept of Effective mass.

PH 353 – Light Matter Interactions(EP 454):

Maxwell’s equations and propagation of light, Fourier analysis, Lorentz model of optical response, optical response of various natural and artificial materials, metamaterials, photonic crystals, polarization of light, scattering phenomena, lasers, nonlinear light-matter interaction, ultrafast phenomena, strong light-matter interaction, plasmonics, and few applications of light-matter interactions like photovoltaics and optical switching.

PH 251 – Classical Mechanics(PH 401M):

(Compulsory)

As the course name suggests, it covers classical mechanics which is nothing but Newtonian mechanics but in a mathematically rigorous way, in detail. Course contents:Review of Newton's laws of motion. Hamilton's principle, variational method and Lagrange's equations with and without constraints. Central force, Kepler's laws. Hamilton's equations, canonical transformation, Poisson brackets. Periodic motion, small oscillations, normal coordinates. Rigid body dynamics, moment of inertia tensor, Euler equations, motion of a symmetric top. Frames of reference, rotating frames, centrifugal and Coriolis forces.

*Apart from compulsory courses the remaining 2 can be taken from list of department electives

5.19 STATISTICS AND INFORMATICS

PREFACE:

As statistical data analysis, modelling and inference are required in almost all areas of the natural and social sciences, technology and industrial research. The skills taught in the SI minor are extremely useful in almost all branches of engineering, as well as in certain non-technical careers. For example, in quality control in mechanical, chemical, metallurgical or electrical engineering, the regression techniques learnt are extremely useful. Stochastic processes are useful in Chemical Engineering and in Physics, while derivative pricing is useful in future financial careers. All in all, this minor increases the analytical skills of the student taking it, which can only be an asset.

SI 417 – Introduction to Probability Theory:
The basics of probability. Prerequisite for SI 402, SI 404, SI 527. It includes: Axioms of Probability, Conditional Probability and Independence, Random variables and joint distributions, Functions of random vectors. Expectation, moment generating functions and characteristic functions, Conditional expectation and distribution functions. Functions of random variables, Expectation, moment generating functions, Modes of convergence, Weak and strong law of numbers, central limit theorem.

SI 402 – Statistical Inference:
Uniformly most powerful unbiased tests, Invariance in Estimation and Testing, Admissibility, Minimax and Bayes Estimation, Asymptotic Theory of Estimation, Asymptotic distribution of likelihood ratio statistics.Sequential Estimation, Sequential Probability, Ratio Test.

SI 404 – Applied Stochastic Processes:

Stochastic processes : description and definition. Markov chains with finite and countably infinite state spaces. Classification of states, irreducibility, ergodicity. Basic limit theorems. Statistical Inference. Applications to queuing models.Markov processes with discrete and continuous state spaces. Poisson process, pure birth process, death process. Brownian motion. Applications to queuing models and reliability theory. Basic theory and applications of renewal processes, stationary processes. Branching processes. Markov Renewal and semi-Markov processes, regenerative processes.

SI 422 – Regression Analysis:
Simple and multiple linear regression models estimation, tests and confidence regions. Check for normality assumption. Likelihood ratio test, confidence intervals and hypothesis tests; tests for distributional assumptions. Collinearity, outliers; analysis of residuals, Selecting the Best regression equation, transformation of response variables. Ridge regression.

SI 527 – Introduction to Derivative Pricing:
Introduction to options and markets: types of options, interest rates and present value. Black-Scholes Model: arbitrage, option values, payoffs and strategies, put call parity, Black-Scholes equation, similarity solution and exact formulae for European options. American options: call and put options, free boundary problem. Binomial methods: option valuation, dividend paying stock, general formulation and implementation. Monte-Carlo simulation: valuation by simulation. Finite Difference Methods: explicit and implicit methods with stability and convergence analysis, methods for American option-constrained matrix problem, projected SOR, time stepping algorithms with convergence and numerical examples. Lab Component: Implementation of the option pricing algorithms and Evaluation for Indian companies.

5.20 SYSTEMS AND CONTROL ENGINEERING

PREFACE :

Control engineering has an essential role in a wide range of control systems, from simple

household washing machines to high-performance F-16 fighter aircraft. It seeks to understand physical systems, using mathematical modelling, in terms of inputs, outputs and various components with different behaviors; use control systems design tools to develop controllers for those systems; and implement controllers in physical systems employing available technology. Students enthusiastic in robotics would find this minor useful in modelling robots and control systems. Systems and Control Engineering is very multidisciplinary in nature with applications in finance, robotics (from self driving cars to military drones), aerospace, mechanical, electrical and chemical engineering.

3 compulsory core courses:

SC 201 – Mathematical structures for systems and control:

Groups (definition, matrix groups - GL(n,R), SO(3), SE(3), the commutator, the Lie algebras so(3) and se(3), applications: robotics, aerospace problems), vector spaces (definition, linear dependence, basis, subspaces, dual spaces, linear transformations, matrix representations, similarity transformations, eigenvalues, applications: control and signal processing) and, elements of differential geometry (n-surfaces in Euclidean space, tangent vectors, vector fields, co-vector elds, geodesics, covariant derivative, applications: robotics, dynamical systems and control.)

SC 202 – Signals and feedback systems:

Signals and systems and their interconnections, convolution, differential and difference equations, state variable models, Fourier, Laplace and z-transforms, regions of convergence, the transfer function, linear feedback systems, the stability problem, the Routh-Hurwitz and root locus method.

SC 301 – Linear and nonlinear systems:

Linear state-space models, solutions, controllability, observability, state-feedback (both continuous and discrete domain.) Nonlinear state-space models, phase plane diagrams, existence and uniqueness of solutions, Lyapunov stability.

Rest are electives, you may choose any two from the list below:

1) **SC 627 - Motion Planning and Coordination of Autonomous Vehicles**
2) **SC 624 - Differential Geometric Methods in Control**
3) **SC 613 - Multivariable Control Systems**
4) **SC 700 - Embedded Control Systems**
5) **SC 602 - Control of Nonlinear Dynamical Systems**
6) **SC 605 - Optimization-based Control of Stochastic Systems**
7) **SC 607 - Optimization**
8) **SC 612 - Introduction to Linear Filtering and Beyond**
9) **SC 616 - Large Scale Systems**
10) **SC 617 - Adaptive Control Theory**
11) **SC 623 - Optimal and Robust Control**
12) **CL 692 - Digital Control**
13) **CL 686 - Advanced Process Control**
14) **EE 640 - Multivariable Control Systems**
15) **EE 636 - Matrix Computations**

More information can be found out here http://www.sc.iitb.ac.in/minorProgram.html

SECTION - 6 : MINOR REVIEWS

Deciding which minor to take is always a confusing task - students often find themselves in a dilemma as to whether they should go for the "popular" minors or something based on their interest. To help ease out the confusion, here are some reviews on some specific minors by the seniors who took them:

6.1 ASHUTOSH KUMAR - BIOSCIENCES & BIO-ENGINEERING

Courses

The department offers currently 8 courses which one can take as BB minor. The courses are:

BB 411- Molecular Cell Biology (Slot 5)
BB 404-Metabolism and Bioenergetics (Slot 5)
BB 405-Molecular Biology (Slot 5)
BB 503-Genetic Engineering (Slot 5)
BB 603- Physiology for engineers (Not a Slot 5 course)
BB 610- Biomedical Microsystems (Slot 5)
BB 400- Molecular Biophysics (Not a Slot 5 course)
BB 507- Molecular Enzymology(Not a Slot 5 course)

Disclaimer- if you miss any slot 5 courses then there can be difficulty to cover up the minor as BB 400 and BB 507 run between slot 1 to 4 generally and BB 603 has no fixed slot and it may clash with your lab courses so try not to miss the other courses. And if you are under the impression that this minor is based on rote learning then you are completely wrong as the courses are concept-heavy"

Motivation-

I actually always wanted to pursue medicine or something in the field of Biology but ended up doing engineering. When I came across the course BB 101 and met the various professors, talked to the TAs and read more about the department then I learnt that I can take up an additional degree in the department too. For the first time, I had seen the incorporation of physics, mathematics and real-life problems in this field which I had thought was restricted only till Physiology. Thus my own personal inclination for the subject and an attempt to explore the subject to a newer and deeper detail was all that motivated me to take the minor.

Review of the courses

BB 411- This course runs with the course BB 503 Genetics which if for PhDs and MTechs. Till midsem concepts of Genetics, population dynamics, and different cases of dominance and

codominance is covered and post midsem there are a lot of topics covered not in more details like Enzymes, metabolism, Experimental Methods used for DNA segregation, DNA structures, etc. Slides and little reading through lehninger is fine.

BB 404- This is again running parallel to MSc students and to the horror Prof has the habit of taking surprise quizzes and may not share slides too. The course covers thermodynamics for the human body and metabolism in a lot of detail and little amount of NMR spectroscopy too. Slides can suffice.

BB 405- Again running with MSc students the course covers the initial part of BB 101 in every basic detail from replication to translation, DNA regulation enzymes, Operons, Nucleosomes and every possible detail you must know about DNAs. Attending lectures is a must as all going through slides and understanding concepts may take longer and moreover, a single book is not followed so you need to look up to various of them so better be on lectures.

BB 503- Pretty similar to BB 405(BB 405 used to be a prerequisite for the course but is not now), the course covers DNA modification techniques, Vectors, DNA cutting and cloning. Again it is concept-heavy and attending lectures is must as slides only has images from multiple books.

BB 603- The course has 2 parts. Prof V.P. Soni's part is easy and slides are enough. Concepts like the endocrine system, AIDS, diabetes, metabolism, acid-base balance, musculoskeletal system, the nervous system is covered. This requires a bit of rote learning and writing long answers.

Prof Rinti Banerjee's part covers Respiratory system, Circulation system and Blood and one needs to attend her lectures as they are quite good and questions are based on what she teaches entirely in class and slides may not be sufficient.

Prerequisite- **BB 507** has **BB 409** as a prerequisite. Others have **BB 101** as a prerequisite only. CPI cut off is low in the range of 5 to 6.

6.2 DHRUV SHAH - COMPUTER SCIENCE

Disclaimer:

As a EE graduate, the choice of a CSE minor was more natural to me than many other departments; please consider your choices carefully and be bold to explore, for that is kind of the point of a minor!

Also, due to the some logistical topsy-turvy and bad judgment, I *may* not be graduating with a CSE minor degree. However, having completed 10 courses (6 graduate) along with both my

BTPs in the department and *almost* having completed the minor should give this article some credibility.

Courses:

The CSE minor is amongst the more structured minor out there with a wide gamut of courses being offered. The offerings, however, are known to change dynamically, which makes planning ahead a tad worrisome (don't!). Some of the courses that have been offered in the last few years are listed below:

1) **CS 207**: Discrete Structures
2) **CS 213**: Data Structures and Algorithms
3) **CS 218**: Design and Analysis of Algorithms
4) **CS 224**: Computer Networks
5) **CS 347**: Operating Systems
6) **CS 416**: Computer and Network Security
7) **CS 419**: Machine Learning
8) **CS 475**: Computer Graphics

The minor requirement asks you to complete 4 of the above (or other relevant) minor courses (specifically, courses tagged **M** that ran in the minor slot) and any 1 other CSE course (4xx and above). This freedom makes the CSE minor one of the most flexible minors after SC. Each of the course offerings focuses on a broad, fundamental aspect of computing and is meant to give one a taste of what computer science and the engineering aspects thereof. Even from the most disinterested of standpoints, an understanding of algorithm analysis and knowledge of computing tools (beyond CS101) is sure to come in handy in every engineering/analytical career path and the early courses in the minor program provides an easy way forward.

My Motivation:

To be completely honest, I did not have a very strong motivation to start pursuing a minor. The very fact that there was an option to pursue courses from another department that could give me a break from my majors without affecting my CPI (freshie concerns!) coupled with the inherent curiosity to explore led me to consider pursuing a minor. I half-heartedly signed up for 213 and 224 in my sophomore year because the course content seemed like something I would enjoy and pursued them with much lesser sincerity than my usual coursework. My parallel endeavors in tech and research found me applying a lot of tools I picked up in these early minor courses and served as motivation to take up more related courses that could complement my skills. I am very proud to know that I have used tool I picked in each of my courses (yes, including Networks and OS!) at some point in my research to my benefit and utter surprise. At some point, I decided against pursuing the M-tagged courses in consecutive semesters and

instead took up other CSxxx courses that seemed more relevant and in each of them, basic concepts and analytical tools you pick up (in say, DSA or DAA) were very *very* useful.

Pre-requisites:

Courses in the minor assume no knowledge beyond the freshman year CS101 course and number theory concepts one is familiar from their JEE days. 207 and 218 are more intensive courses that would excite the analytic head and arguably, more mathematics than computer science-y. DSA is usually the first course offering in an odd semester and a prerequisite for all other courses, so one is advised to start with DSA at the earliest. The broad interest in the CSE minor also means that it observes some of the highest cutoffs, with the early courses (213/224) closing in the high 8.XXs. Once you're through with these, the later courses have diminishing takers and the cutoffs drop significantly. Having taken DSA, the other courses do not chain as prerequisites and one is free to pick a trajectory of interest.

Words of Wisdom:

(i) While the CSE minor does give you freedom in terms of choice of courses and the requirement of 4 courses means you only need 4 semesters of minor slot classes which means you can even attempt a double minor (more so as a DD), I'd suggest you to not plan ahead and get done with the courses at the earliest. The department is notorious in shuffling the course offerings every semester and more often than once, students have found themselves missing out on the minor degree due to this mismanagement and bad judgment on their part. (ii) In all fairness, the CSE minor as a whole is not a *chill* minor: you will be expected to put in decent hours to pull off above-average grades, especially in courses like 207, 218, 224, 475. Plus, you'll find it much easier to sail through if the course is something you are naturally interested in, or involved in the form of a self/external project or internship. (iii) While "placements mein help hoga" is not a wrong motivation to take up the CSE minor, you should be prepared for the formalism that an institute course entails and the breadth that comes along with it. The structure is not intended to be a crash course for placements/internship interviews and will require significantly more effort and considerations. Cheers!

6.3 KUSHAGRA KACHOLIA - CTARA

Courses:

Centre for Technology Alternative for Rural Areas offers the following 3 courses each semester, worth 6 credits each, as semester long RnD projects as a part of TDSL (Technology and Development Supervised Learning):

1) **TD 390:** Supervised Learning-Study
2) **TD 490:** Supervised Learning-Analysis
3) **TD 491**: Supervised Learning-Design

The project is generally to be done in a group, but there might be exceptions if the Professor agrees to allow a single student to take the course. Each group is expected to have completed at least 3-4 field visits in rural areas during the semester and are graded on a final presentation and report submission just before the endsems. As evident by the names of the courses, one is expected to identify and study the issue to be tackled in the first course, analyse the root causes and narrow down to the specifics in the second, and propose a potential solution in the last one. However, there is generally no clear distinction between the three and you may end up designing a solution in TD390 itself. The workload varies quite a lot depending on the Professor you choose to do the course with.

My Motivation:

Having clearly made up my mind right in the first semester to not put my hands in anything even remotely related to Core Mechanical, I found myself trapped in the guilt of potentially passing out of IIT without taking up even a single project. While browsing through the list of courses that could be taken up as institute electives, I came across TD390, which according to me is as close to a “Non-Core” project as one can find in insti. It promised to help develop a wide variety of interpersonal skills, while simultaneously allowing to have an unbeatable on-ground experience in the rural areas of Maharashtra. Although really skeptical at first, I decided to go ahead with it with a couple of my friends as team partners. Such amazing was the experience that by the time TD390 was over, we could not wait to begin the next one in the spring semester. Having completed TD490 in the sixth semester, we are looking forward to taking up TD491 as well, even though we do not have any institute elective left now.

Pre-requisites:

Apart from a 6.5+ CPI, one really only needs to have the passion to carry the enthusiasm forward till the end of the semester. It is very important to clearly define the project goals and objectives to stay on track and not lose focus in between. Meeting with the project guide fortnightly and clearing the doubts and discussing the progress can go a long way in successful completion of the projects.

Miscellaneous advice: (The most important section :P)

One should be careful to not get too excited by the grading statistics of the course (which is quite good by the way) as a decent grade is only guaranteed if the project is completed on time and all the goals have been achieved successfully. Also, try avoiding taking projects involving visits in open areas in the Autumn semester as the weather can be a brutal force to encounter. Choose your team-mates wisely as there might be a phase where you’d feel like giving up and would require some support and encouragement. Last but not the least, the projects can help you secure an internship or two (at least in my case they did :P), as well as help you while filling your higher studies applications as it involves some amount of social work, but only if done

properly and with complete dedication. These courses can turn out to be one hell of an experience and I would recommend all the enthusiastic people to give it a go.

6.4 PUSHAN BAL - ELECTRICAL

Disclaimer:

I am an ardent believer in the applications of basic knowledge of electronics in almost every discipline and this review may be biased a bit towards the good side. I will try my best to keep it neutral but certain inclinations are bound to happen. Take everything you see here with a pinch of salt ;)

Courses:

Out of the six available options, one has to complete five. All courses are worth six credits. The courses are:

1) **EE203** Electronic Devices
2) **EE204** Analog Electronics
3) **EE210** Signals and Systems
4) **EE221** Digital Electronics
5) **EE321** Power Electronics
6) **EE325** Probability and Random Processes

All the courses ensure that one gains certain skill sets that every engineer must have in his kitbag. Very versatile, students will find applications in almost every field of study they encounter.

My Motivation:

I wanted to pursue postgraduate education after completing BTech here. One of the most important aspects of research is the analysis of data which is mostly electronically generated. A sound knowledge of electric circuits really helps one distinguish between actual data and the background noise. This is very important because I have seen many people misinterpreting something other than actual data as their results and having messed up. Designing measuring equipment is also a huge part of research since one may need to measure something specific for which there are no standard instruments available. A working knowledge of electronic circuits come really handy in these situations. This was my primary motivation to opt this minor. I have completed four courses till date and will finish the minor next semester. However, a word of caution, It is very important to select the order of courses to be done very carefully. If chosen wrongly, one might feel that the minor is boring and may be inclined to drop it. Well, in that case he or she will be deprived of a very interesting experience.

Pre-requisites:

If one has paid reasonable attention to the electrical circuits part taught during JEE days, which you must have since you are here, it will be really easy to follow the courses. This is a type of minor in which the core concept is very short but is the heart of the matter. If one pays attention in class and gets that crucial concept, he/she does not need to study specifically for the minor. A few days before the exam is sufficient. If your CPI is around 7-7.5, you should get one of the six courses for sure though I can't guarantee that you will get one of your choices.

Word of Wisdom :P:

I have stressed this to everyone who cares to listen to me that a minor is not to be taken so that you might get shortlisted in so and so company. If you take a minor, it is your responsibility to attend each and every lecture. Make notes by yourself, attempt the assignments by yourself. Do not treat it like " yaar pass ho jayenge". I know most of you will but then think about this. You are investing 3 extra hours of your time per week learning this. You might as well make the best of it. You must be highly motivated to get up for 9:30 am lecture on Wednesday and Friday even when your roomie doesn't have a minor and stays sleeping. If you think you are up to this, then and only then should you take a minor.

6.5 PRASANNA KUMAR - ENERGY

Motivation

I have taken the minor because of my interest in renewable energy technology. There are many courses which we can choose from and are mentioned in the energy department website briefly. There are three compulsory courses EN301, EN 403, EN 410/607. On the whole, doing a minor in energy is very insightful if you are interested in current energy technology. I have discussed about the courses I did in my minor. The difficulty of the courses is in the range of 1-5.

Myth: *Just doing a minor is enough*

Some people choose the minor just for the sake of doing it thinking that it will help in internship or placement but end up getting bad grades which defies the purpose. If you have a real interest in some subject then better to do those minor courses rather than opting some minor just because others do it. Many people discontinue their minor as they lose interest in due course of time.

Courses :

- **EN 301**: Introduction to renewable energy technologies

  Professor: Chetan Solanki

Difficulty: 2

Remarks: It's an easy course if we attend classes. Professor discusses the problems in class and most of the questions in exams are related to it. This course has surprise quizzes but that won't be an issue if we have your notes as they are open book. There are very good reference books with solved problems and the professor will mention them in the class. The exams, mostly consist of problems and some conceptual questions. On completing this course you will know about all kinds of renewable energy technologies and applications.

- **EN 403**: Energy resource, environment and economics

  Professor: Srinivas Seethamraju

  Degree of toughness: 2

  Remarks: The professor will upload detailed slides and tutorial problems but the thing is that he doesn't upload the solutions and there are no special tutorial sessions. All the problems are discussed in the class. The number of quizzes depends on the opinion of the students. It also consists of some assignments but all of them are easy and doesn't require much effort. The midsems have some conceptual questions but the endsems consists of only problems and cheat sheets are allowed. The exams are very easy if we do the tutorials and the problems the professor did in class.

- **EN 410/607**: Energy management

  Professor: Srinivas seethamraju

  Remarks: The exam pattern and difficulty are all the same as EN403. Since it's a PG course the content covered is more compared to EN 403, so my advice is to read slides beforehand as it can’t be completed in one night.

- **EN 630**: Utilization of solar thermal energy

  Professor: Karthik Sasihithlu

  Difficulty: 3

  Remarks: It’s a very well structured course. The professor gives very detailed notes which are more than enough, no need of any other reference material. There are no assignments. Quizzes are informed well before and it has both MCQ which are mostly conceptual and problems. There are no tutorials, the professor discusses the problems in class and you can also find most of them in the reference book he says. Cheat sheets

are allowed in exams, so scoring well in midsem and endsem won't be difficult as they have only problems and no conceptual questions.

- **EN 658**: Electrochemical energy storage

  Prof: Sagar Mitra

  Difficulty: 4

  Remarks: This course is very different compared to others. There are no proper reference books and the problems asked in quizzes and semester exams are based on the concept taught in class but they are not straight forward and can only be solved if you have the basics right. There are surprise quizzes but they are all open book. There is a course project but not that time-consuming. This course is preferable only if you have a real interest in battery technology.

  I have discussed only about some courses but there are a variety of courses ranging from battery technology to nuclear power and you can choose the courses according to your interest.

Future Prospects:

There is a huge scope for renewable energy and battery technology in the near future, so having a good idea about these will be useful in case you want to do higher studies in these fields. The minor courses gives you a stronghold in the basics of energy technology so that you will have a very good idea on what interests you by the time you complete the minor.

6.6 OWAIS CHUNAWALA - ENTREPRENEURSHIP

Context & Disclaimer: I am very passionate about entrepreneurship. Therefore, I took the Entrepreneurship Minor to learn the skills needed to be an entrepreneur. I took my first ENT course about 2 years back (Autumn 2017) and I have completed the Minor last semester (Spring 2019). I started my venture (Augle.ai) at the end of my sophomore year in April 2018 along with my teammates. I have since then focused on my startup along with the academics. I haven't done internships in my second & third year summer so that I can work on my startup. I feel that I might be an outlier, as I was fortunate enough that my parents allowed me to work on my venture while being in college. This might not be the case with a lot of students reading this review. You might want to just get an idea about entrepreneurship, or start your venture after your graduation or sometime in the future. So be a bit careful while making your decision as I might be biased.

Courses: The following are the list of courses along with their respective credits

ENT 201/603: Introduction to Entrepreneurship **(Credits: 6)**
ENT 207/605: Business Fundamentals for Technopreneurs **(Credits: 3)**
ENT 209/607: Managing Technological Innovation **(Credits: 3)**
ENT 204/606: Developing a Proof of Concept-Basic **(Credits: 6)**
ENT 210/604: Marketing for Entrepreneurs **(Credits: 3)**
ENT 205/601: Intellectual Property Management for Entrepreneurs **(Credits: 3)**
ENT 206/608: Developing Proof of Concept-Advanced **(Credits: 6)**
ENT 208/602: Technology Venture Creation **(Credits: 6)**

All the courses cover the concepts and topics that you need in your arsenal to create a successful Business Venture.

More than 90% of startups fail. That is a very high failure rate. The courses ensure that the students learn about the majority of mistakes made by other entrepreneurs which lead to failure. They also teach frameworks which could ensure that you don't make those mistakes during your journey. Any startup involves a huge amount of risk, the greater the risk, the greater the reward, the courses help you to systematically reduce the risk as you go on your startup journey. Which will increase the probability of your succeeding. In the courses, you will learn about the basics of business, how to build prototypes & Minimum Viable Product (MVP), how to scale your business and much more. Also, every course has few set of lectures taken by experts in various fields ranging from finance, entrepreneurship, venture capital and many more. These lectures are amazing as every speaker has something great & unique to share from their experience.

Work requirements: Most of the courses require you to form a team initially with the course mates, go out of the building to test your ideas, identify the need by talking with potential customers, and building the MVPs of your ideas. All the courses except the Proof of Concept Courses have written exams, which carry approximately 50% of the final marks. The written exams are not very difficult given that you have paid attention in class. The remaining marks are allocated based on the multiple presentations that you need to make with your team during the course. Multiple professors from the Desai Sethi Centre are judging the presentation. If you haven't put effort outside the class, then, that can be easily judged during the presentation.

Prerequisites: There are no prerequisites or CPI constraints for taking this minor.

Conclusion: Desai Sethi Centre for Entrepreneurship is not like any other department in the institute. Apart from courses, the centre helps you in multiple ways like providing funding for building your first product, connecting you with initial customers & investors, mentoring & guiding you during your startup journey. All these factors can be a great head start for your venture. And the centre also helps you even if you have graduated.

Personally, I have been able to gain a lot of value from the learning in the courses by implementing them on my startup in parallel. We (Augle.ai) has won multiple entrepreneurship

competitions, raised funds and also found some customers. All this would not have been possible without the learnings, help & support that I received from DS Centre. Do give these courses a try. All the best!

6.7 AKASH ANUMARLAPUDI - ENGINEERING PHYSICS

The Why :

I am sure that you are self-motivated, but this is for those who want to try/ aren't sure of EP minor. You would already have realized that in most of the branches, Physics plays a vital role in the courses (may it be Semiconductor physics in EE or Mechanics in CE/AE/ME). Minor in EP primarily focuses on giving an in-depth understanding of physics of particles all the way from atomic to microscopic to the macroscopic scale.

The What:

Nominally minor in EP is equipped with five 6 credit courses comprising of –

1) Introduction to Quantum Mechanics (QM),
2) Thermal and Statistical Physics,
3) Condensed Matter Physics (CMP),
4) Classical Mechanics
5) Light Matter Interactions.

Although some of them sound familiar and may seem like you already have a working knowledge of them, every course offers a completely new area of study although I wouldn't argue against some overlap in a few courses. I am sure that one can find the course contents on ASC, but just to give a brief summary of what one can expect:

QM is a mix of math and concepts, as in the first half deals completely with math (Inner product spaces, their duals, Matrix Algebra, Linear Operators, etc..) which is thoroughly used in its latter half when the notion of dual nature of electrons in potential wells (at this point one may find a bit of overlap with QM done in 1st year) is introduced and extended to its behaviour in an H atom.

It can later be accompanied by Quantum Statistics, introduced by Statistical physics, which deals with the distribution of particles over energy states (Fermi-Dirac, Bose-Einstein, Maxwellian velocity distributions pop up here). Heat transfer is taken up in Thermal Physics which completes the course Thermal and Statistical Physics.

Atoms/Molecules as a whole are covered in CMP which explains how atoms combine to form the physical structure (Photoelectric effect, Scattering, Propagation of waves in a solid and many more..).

Classical Mechanics is very distinctive from the one taught a priori as in the so-called 'Analytical Mechanics' comprising of concepts like generalized coordinates, Euler-Lagrangian formulation, the Hamiltonian formulation will be introduced. This course is highly mathematical in nature, but this formalization forms the building blocks for General Relativity and Quantum Field Theory.

Light Matter Interactions, as opposed to remaining, is partially experimental in nature. It deals with Maxwell's wave theory formulation and matter response when lightwave disturbs the atoms in them (Laser cooling, metamaterials, plasmonics, ultrafast pulses, etc.. will be introduced).

The How :

There is no course which is/ has a prerequisite and no definitive order in which courses are to be opted. There is no rigid CPI cut off for this minor. I should warn you that minor in EP is mostly theoretical which includes a plethora of mathematics, so taking up EP minor just to have one is precarious. There is no correlation that favours people of one branch over the other, anyone who is interested will be intrigued (I certainly was). Missing a couple of classes will do no harm but too much irregularity makes it difficult to cope up since a decent amount of material is covered in each class.

6.8 ISHITA SHAH - HUMANITIES

Disclaimer: My HS minor so far comprises of only literature and economics courses, so most of the review ahead is based on my experiences with these courses only.

A brief introduction: HS minor is unlike any other minor as there's a multitude of courses that you can pick from fields like literature, economics, philosophy, psychology and sociology, and build your own basket of courses to complete the requisite credits.

While picking literature courses, it is a good idea to go by the professor who's offering the course as opposed to the course content, as the content changes drastically based on the professor. That said, the courses that I've done so far are as follows:

HS 208: Approaches to Literature

This course ran in two halves, the first half was taken by Prof. Sudha Shastri and the second half by Prof. Suddhaseel Sen. Sudha Shastri taught a novel and a bunch of short stories with themes that were brought out at different places in the main novel. The discussions were based on each of the independent pieces and also drew comparisons between the short stories and the novel based on common themes. Prof. Suddhaseel on the other hand, generally takes a Shakespeare play and another long piece, which may be modern or classic.

HS 457: Managerial Economics

This is a pretty standard economics course, and the course content can be easily found on the department website. The professor, Surajit Bhattacharya is very particular about the coursework and regularly hands out reading material that he expects all students to be updated with.

HS 411: Indian Economy

This course spans a huge number of aspects of the Indian economy. The first half of the course deals with the trajectory of the economy from India's independence till date while the second half deals with specific major sectors of the Indian economy like railways or the telecommunications industry (in the form of a project). The professor, K Narayanan is very enthusiastic about the course and offers examples from recent news to explain key ideas which makes it interesting and easy to follow and retain.

(In the HSS department course codes tend to change, so search for reviews by the course name on the website)

My Motivation: A love for literature and a need to keep in touch with reading motivates me to take up at least one literature course every semester. I like to study economics because it helps me understand how individuals, businesses and governments work and manage resources efficiently.

Pre-requisites:

There are virtually no prerequisites to literature courses. However it is strongly advised that one shouldn't miss lectures as these courses are largely discursive and there's no substitute to attending class.

For economics, you should have completed the HS101 course that runs as a core course. It is not a prerequisite for registering for other courses, however these courses use the content taught in the 101 class and professors scorn in disdain if you ask questions relating to that.

Future prospects:

While there is virtually no 'future prospect' for doing literature courses, the pleasure derived from attending lectures is the motivating factor for most who take these courses. On the other hand, economics courses help you to understand the rules of the world and a basic knowledge of economics is very important for almost any non-core field.

On a concluding note, I'd like to say that these courses demand attendance (especially literature) and class discussions can not be made up for by reading content online or watching videos.

6.9 SOHAM KHADTARE - IDC

Courses

Industrial Design Center offers a lot of courses that can be tagged as a minor course(M) or an institute elective(I). A total of 30 credits are required to complete the minor. Since all courses have 6 credits, one must complete any 5 courses to get a Minor in Design.

The list of courses that can be taken up as a minor is posted on IDC Website. Although the list of courses offered is long, IDC may choose not to run one or more of the courses in any given semester. Generally, IDC runs 2-3 courses per semester.

Apart from the courses you can take in Slot 5, IDC offers Studio Projects. They basically function like any of the BTPs. You approach a professor with a project idea in his or her area of interest or ask professors to give you a project and fill a manual registration form from the IDC office. The professor will guide you through the duration of the project.

I have completed the following courses as a part of my Minor in Design:

DE 401：Basics of Visual Communications

Taught by Prof. Raja Mohanty, the course covers the use of graphics as a tool for communication. The content of the course varies each year. I had to make a book as a part of the course.

DE 410 : Perspectives on World Cinema

Taught by Mazhar Kamran, a film director and a professor at IDC. The course is about film appreciation. The professor screens a movie once a week and conducts a discussion in class about it. The course requires you to maintain a diary which contains your understanding of each film and a final presentation about your favourite film director and his style.

DE 402 : Introduction to Design - Case Studies

Taught by Prof. B.K. Chakravarthy, the course is about introduction to Product Design. It teaches you the process involved in designing a product as developed by the professor. It involves identifying a problem and designing a product for it.

DE 408 : Elements of Design

Taught by Ravi Hazra, the course teaches you about basic elements used in design like line, colour, shape, typography and the use of sketching as a tool to prototype ideas.

DE 407 : Technology and Animation

Taught by Sumant Rao, the courses involves a study in the technology that went into the development of animation. It spans the history of animation and the technological developments that gave rise to the VFX industry that we have today.

Motivation

My motivation to complete the minor was my interest in design. It helped me to identify my areas of interest and pursue a masters degree in it. Design has a lot in common with many engineering fields and collaboration with engineers is quite common in Design.

A common notion in the institute is that Design Courses are 'chill' as compared to other courses. Although they have a fraction of the load that fellow design students do, the evaluation is continuous and requires a student to attend classes, interact in class and submit a bunch of assignments to get decent grades.

Future Prospects

A Minor in Design gives a brief introduction to various fields available in creative problem solving and its application in the industry. It helps in choosing a specialization in design which you would like to study in depth in your masters or pursue a career in that field.

What does the Minor offer?

A lot of people mistake Design for Art and miss an opportunity to learn a lot. Design is Creative Problem Solving. It covers a lot of fields like Graphics, Animation, Product, FIlm, Interaction, Textile and many more. Design has a lot in common with Science than with Arts. The Minor usually functions as an introduction to these various fields. It is upto the student to interact with the professor and find out more about the work done in his or her field and gain knowledge about it.

The two important takeaways from the minor are: **Theory and Process.**

Theory involves the technical aspect of Design. For example, Gestalt Theory draws conclusions about the way humans perceive things.

Process is the way a designer arrives at the solution to a problem. Although this method is quite similar for all, each Professor has his or her own process.

Prerequisites

There are no prerequisites to take a Minor in Design. Anyone can take this minor.

Miscellaneous Tips

- Pottery is one of the most popular courses that is taken as a Studio Project by students. The common misconception is that it is easy to get good grades. People line up outside IDC Office way early in the morning (sometimes at 2AM) to get a seat in the course. My Advice: Don't. You should take Pottery if you want to de-stress and relax by making pots in between a busy schedule. Pottery is more of a Craft than Design. Yes, there is a difference.
- Most courses run in the Minor Slot except for Studio Projects. Compared to other minor courses offered by IDC, Studio Projects have more interaction with the professor and hence provides a great opportunity to learn. Look up the interests of professors on IDC website and contact them with project ideas which can be taken up as a Studio Project.
- As a part of the courses, you will get access to the different Studios in IDC. Use the opportunity to explore as much as you can.

6.10 SRAVAN PATCHALA - IEOR

Disclaimer :

At the time of writing this blog, I have completed IE 501, IE 503 and 4 IE labeled Electives (IE 612, IE 613, IE 645, IE 708). My aim via this blog is to give you an idea of what to expect from the elective courses and the minor in general. You'll have to do the compulsory courses anyway, so you do not have much choice there :P Anyway, I do have a brief description of the courses I have done, so do give that a read.

What exactly is IEOR?

I have been asked this question multiple times and have struggled to answer it every single time :P Sadly, there is no one good description I have come across.

The way I see it, this discipline covers a wide range of problem-solving techniques that help in increasing the efficiency of systems and/or better decision-making. It takes help from traditional Industrial engineering models and improves upon it using the current techniques used in operations research. Simply put, it is a subfield of applied mathematics that deals with optimizing some real-world objective and making better decisions.

If you didn't get this at your first attempt, no worries! The best way to understand what people in IEOR work on is to have a look at the courses the department offers. I am pretty sure you will find something or the other that will grab your attention. If you are more curious, you could do a quick Google search on IEOR, and find yourself amidst many interesting topics and applications.

List of courses :

You can find the courses you need to do in order to fulfill the Minor requirement here (http://www.ieor.iitb.ac.in/acad/minor). Honestly, the electives are the best part of this minor. The wide array of topics ranging from Learning to Pricing to Planning can cater to any kind of interests that you have.

Exemption of the compulsory courses might be made subject to approval from the concerned authorities. For example, if you already have a strong background of (or done relevant coursework in) probability, perhaps you can request for an exemption from doing IE 502.

Why this minor?

At first, I had no intention of doing a minor in IEOR. I just happened to have an empty slot and thus picked IE 501 as an ALC and then went on a few semesters without taking any courses. Now I have ended up doing even my Institute Electives in this department. Being interested in probability and applied math, this minor caught my eye. If you are one of those who like to see a mathematical model for the real-world scenarios, this is the best choice for you.

The key thing to note here is that despite being a math-inclined stream, most of the concepts rely heavily on intuition and common sense. The mathematical rigour you find in the MA courses is usually absent here, which might be something to rejoice (or lament, depending upon you).

This stream is very different from the traditional engineering ones. Most of the reputed universities over the world have established this department in recent years, signalling a steady increase in demand for people from this field. Even though the IEOR@IITB offers substantial variety in coursework and research, there are multiple educational programs abroad that offer significantly more diversity in the applications and research topics. If you are planning to pursue something along those lines, then a minor in IEOR might be the best step forward. Moreover, since it has applications in almost every other industry, it might be a very useful tool to have!

A brief overview of courses done by me:

Each course will have quite a few concepts covered as a part of it. Almost all concepts in each course are backed by relevant real-life examples. You can find the grading stats and instructors on ASC and judge for yourself whether the course is “chill” or not.

IE 501 - Optimisation Models

The best course to start off with, if you want to pursue this minor. It builds from the linear algebra everyone studied in MA 106 to solve linear convex optimization problems.

The course moves at a very steady pace. The first half of the semester covers the formulation and modelling of a given problem as a linear convex optimization problem. This formulation and

modeling is something that is repeatedly used in most courses of the minor. So it might seem trivial at first, but time spent here is very valuable.

Techniques to solve the optimization problems are covered in the second half of the semester. Important concepts of Duality and Simplex method are taught here, which are the basics of solving most of the optimization problems. And not to forget, the instructor does throw in real-world examples throughout the course, to help the student to appreciate the concepts better.

The exams are on the easier side, with the endsem being an exception. The course might have (coding) assignments depending upon the instructor. On the whole, getting a decent grade should not be a problem with average efforts.

IE 503 - Operations Analysis

A very interesting course, which everyone can relate to very easily. The applications of the topics covered in this course are easily visible in our day-to-day life.

The course is well organized, with topics being covered with sufficient time and examples provided at every step. The first half covers the various technical terms and structure of supply-chain, with a heavy emphasis on providing the right kind of examples. The second half deals with more about scheduling and optimizing the operations involved in the manufacturing process. Inventory models are also covered in this half.

The exams are pretty easy and can be easily tackled if you grasp the concepts well. There were two quizzes along with a midsem and endsem, with none of them being particularly tough. Getting good grades in this course should not be difficult as most of the questions in the exams can be easily solved using some common sense.

IE 612 - Introduction to Financial Engineering

This is one of the most unique courses offered by the department. If you are looking to venture into the field of Finance, then this might be a good tool to have in your tool-box. The course does not assume any previous “finance” knowledge but does require a lot of mathematical aptitudes. Also having a good background in probability would be really helpful towards the end of this course, without which doing this course might be a struggle, particularly towards the end.

The course content (and thus the lectures) closely follows the reference book prescribed by the instructor. Topics like portfolio management, arbitrage, hedging, the pricing of Options and Contracts are covered in the course. Most of the topics involve simple but important proofs which are tested during the exams. Concepts like Stochastic Calculus might be touched upon if time permits.

The time allotted for each topic decreases as the course progresses, notwithstanding the increase in the difficulty of the topics. So it wouldn't hurt to attend lectures or do some reading on your own from the reference book. The difficulty of exams typically increases over quiz 1, Midsem, quiz 2 and the Endsem, but that can be attributed to the increase of difficulty in the tested topics.

On the whole, if you are thinking that doing this course will make you one of the best in the business, you are mistaken. It just makes you comfortable with some of the relevant literature. Also, it should build a decent foundation if you want to pursue something in that direction. But everything comes at a price - Getting a good grade would require a substantial investment of time towards this course.

IE 613 - Online Machine Learning

First things first. Yes, it is another machine learning course. But it has one important difference and that makes it worthy of having a different course for this. In "offline" ML (the one everyone is accustomed to), one assumes all the "train" and "test" data is available for use all at once. In "online" ML, the assumption is that data samples arrive in sequential rounds. So in each round, the "online" ML algorithm chooses the appropriate "best" action. Designing and analysis of such algorithms are what is covered in this course.

The course covers some interesting algorithms in the beginning. Gradually, the course takes a strong inclination towards performance analysis and proving certain bounds, which might seem slightly uninteresting. Verification of these performance metrics and bounds using empirical data is a typical coding assignment in this course. Finally, the course covers a variety of interesting bandit-problems. The course also has a course project towards the end, which typically involves implementing and improving on a related research paper.

Also, doing this course in parallel with a traditional ML course might be slightly beneficial. It would give a better insight into certain common topics and algorithms. On the whole, the course has a single exam during the midsem period, which is typically an open-book exam. So apart from the midsem, every other graded part of this course is to be done "offline". So getting a good grade would be easy with periodic efforts.

IE 645 - Industrial Scheduling

This is easily one of the most difficult courses you'll come across in this department. As the name suggests, the course deals with scheduling (and/or sequencing) of multiple "jobs" on multiple "machines" in order to meet certain objectives. More specifically, the course deals with a variety of algorithms that achieve these objectives.

The first half of the course goes at a decent pace, with considerable time spent on definitions and measures of performance. The second half goes at a quicker pace, covering topics each of

which are sourced from different research papers. This is what makes the course difficult. Although the course does not have any prerequisites, it is highly recommended that this course is taken after doing IE501. The instructor takes great effort to teach concepts from scratch, but it might be difficult to digest the vast content without having some prior exposure.

The lectures are a mix of solving examples, revising previous concepts as well as teaching new concepts. The instructor regularly calls students to the board to solve certain problems. So it is always good to be present physically (and mentally) in the class. The exams are on the tougher side, with the entire class scoring less than 50/100 overall, despite of the exams being open book. Given that, grading is lenient (Long live relative grading :P).

So if all that has intimidated you, then let me say that doing well in this course is easy, provided you are willing to struggle a day or two before the exams. The instructor reads through each and every answer written in the exams and tries his best to give marks wherever due. Thus it is not as difficult as it sounds to get decent marks in the exams.

IE 708 - Markov Decision Processes

This course deals with decision making in stochastic systems. In simple terms, it helps design policies that take actions to minimize (or maximize) cost (or profit) over some timeframe. This course does require sufficient knowledge of probability and so it is strongly advisable you do this course after doing a probability course.

The first half of this course is spent in laying the framework of the problem and providing dynamic programming algorithms to solve the decision problems. The second half of the course introduces the concepts of policy iteration and value iteration. The course touches upon some concepts of Q-learning at the end. On the whole, the entire course moves at a steady pace, with most of the time spent on proofs of the results.

The course has a couple of quizzes along with a midsem and endsem, which were pretty easy. At the end, there will also be a course project (and presentation), where the idea would be to read and implement related research papers and perhaps suggest improvements on them. This takes quite a lot of time and effort since the papers are not easy to decode.

On the whole, the course is moderately difficult, especially if you have not seen such kind of problems before. If you do take this course, you'll have quite a lot to learn from the course project if you can devote sufficient time to it. Otherwise, it might be really difficult to get through with a decent grade.

6.10 ABHIJEET AANAND - MANAGEMENT

I think it would be good to begin this review, trying to answer an obvious question. Why Minor in Management in an engineering institute? Well, it always helps being aware of some basic

management basics and principles which can be applied to very diverse scenarios. But, in a broader context, the growing importance of management education in some form for all professionals, especially engineers like us can't be ignored. A minor in Management basics aims to provide introductory exposure to students regarding various facets of management like marketing, strategy, human-resource, operations,finance etc and is equally suitable for people from all branches.

Like other minors, completing this minor requires doing five courses and these five courses can be picked from a bracket of six courses namely, Marketing Management, Accounting and Finance, Strategic Management, Human Resource Management, Operations Management and Project Management. The initial three courses usually run in odd semesters while the later ones are usually offered in even semesters. With the exception of Strategic Management, there are no prerequisites for the courses. In order to register for Strategic Management, one is expected to finish at least one course from the bracket of other five courses. All these courses are offered in the minor slot and the registration limit is usually 40.

Well, it's an implicit assumption that people pursue a minor because they are interested in something beyond their major. In my opinion, if someone is not really sure about any minor, a minor in management can be a handy choice owing to the different dimension it adds in one's academic profile. That was one of my primary motivations while going for this minor. Contrary to most people who opt for this minor hoping to build their profiles for non-core jobs, I had a totally different approach and that has proven to work for folks like me who are really interested in core engineering. However, this minor is a really good option for those folks who are really sure about going for non-core jobs. But, for people who are considering this minor a substitute for an MBA; they might be at the wrong place. This minor can never be a substitute for an MBA but the experience gained while doing this minor can definitely help somebody when deciding whether he/she wants to go for an MBA later.

Coming to the classroom atmosphere, most of the professors are really enthusiastic about their courses. The lectures are carefully planned and at times,the entire course plan is handed during the first week of the course. The students are expected to read the case-studies handed over to them before coming to the classrooms and at times, students are evaluated based on the assigned pre-reading. The atmosphere in the classroom is very different from usual courses with a lot of emphasis on class-participation. Some of the professors even consider class-participation for evaluation and subsequent grading. With unannounced surprise quizzes and class-participation considered for evaluation, having good attendance helps a lot in achieving good grades. Most of the courses also have a group project which carries a significant weightage in final evaluation.

However a word of caution in case you are opting for this minor. Unlike most of the other minors, courses offered in this minor can't be later re-tagged as a department or an institute elective. In case, somebody is unable to finish the minor, he/she might not be able to capitalize

upon any good grades achieved in any of the courses. Also, people aiming to get this minor in waitlist might be having a tough time because professors are really particular upon keeping the enrolment cap to 40. In most of the cases, with a CPI of 8.6 or above, one can be fairly sure to get this minor during pre-registration. At times, the course content seems too trivial but getting good grades becomes a tough task due to a fairly comprehensive evaluation methodology adopted by professors.

Based on the reviews of my batchmates, I would suggest anybody who isn't serious about this minor to at least go for course on Accounting and Finance . For people who are really serious about this minor, starting with Marketing Management can be a really good idea owing to really amazing professors and relatable course content. One final word of advice for people taking up this minor. There might be times when you may be tempted to think along the lines that most of the things being taught are fairly straight forward and it's not a big deal. Just hold on for sometime and remind yourself that once you land up in a job or in a corporate setup, these seemingly basic things will prove to be a big deal.

6.11 ARKYA CHATTERJEE - MATHEMATICS

Courses

The mathematics minor is aimed at covering topics that are central to almost all of contemporary mathematics. At present, there are four courses in the minor program -

1) Real analysis (RA)
2) Complex analysis (CA)
3) General topology (GT)
4) Basic algebra (BA).

Pre-requisites

BA and RA, which are typically run in odd semesters, don't have prerequisites, whereas RA itself is a prerequisite for both CA and GT, typically run in even semesters. All of the courses are worth 8 credits, with 3 lecture hours and one 1-1.5 hour tutorial per week.

Course Review

I took RA, GT, BA and CA in my 3rd, 4th, 5th and 8th semesters respectively.

1) RA deals with topics like sequences, power series, the convergence of functions, point-set topology (in the context of the real numbers), and a little bit of differentiation and integration. Although some of these are also discussed in the freshman calculus

course, the spirit of mathematical rigour and the importance of proofs is emphasized to a much greater extent in this particular course.

2) CA deals with the calculus of complex functions and other complex analogues of the topics of RA. The course content depends on the instructor to quite an extent.
3) GT is the most abstract of all the minor courses. It constitutes a study of sets endowed with a very basic structure, namely “openness”. As a result, it gives rise to very deep and widely applicable theorems and opens up various avenues for the motivated student to explore as a follow-up to this course.
4) BA exposes the student to algebraic structures such as groups and rings. Algebra, being a very classical topic in mathematics, constitutes an immense body of knowledge. Keeping that in mind, this particular course, justifiably called “basic”, has a very modest goal - that of introducing the student to the field of abstract algebra.

Motivation

Like with any other minor, doing a mathematics minor won’t make you an expert in any of the topics mentioned above, but it will allow you an opportunity to get a taste of how to think like a mathematician, relying on logic and the ability of abstract and creative thinking, which are valuable skills in any STEM field. My personal motivation to take up the math minor was to develop an appreciation for the mathematics involved in theoretical physics since I was interested in pursuing research in this area.

Words of Wisdom

There are a few personal comments that I should make here.

1) It is highly advisable to take RA as the first math minor course since it helps the student develop a sense of how to think about rigorously proving mathematical statements - a skill that would be indispensable in all math courses.
2) Since the lectures are 1.5 hour-long, a typical lecture covers quite a lot of material. Therefore, being irregular in class can turn out to be detrimental to your understanding of the topic(s) being taught, not the least because the instructor often tends to rely on concepts built up in a previous lecture.
3) Don’t worry if you are not able to clear the CPI cutoff during pre-registration; most math professors are more than willing to let motivated students take up courses even if they don’t have a high enough CPI.
4) Especially since the current list of courses allows no freedom in terms of choice of courses, taking up math courses as electives could be a less-restrictive way of doing courses that you like rather than opting for a minor and being forced to do a course that you might not like.

6.12 ARCHIT GUPTA - STATISTICS

Courses:

There are five courses which are available from the Statistics Department for students wishing to pursue a minor. The first three mentioned below are 8 credits, and the other two are 6 credits each. The requirement for a minor degree is a minimum of 30 credits. Thus completing the first three courses is mandatory and either of SI404 or SI527 can be taken.

1) **SI417 Probability Theory:** This is the foundational statistics course and also a prerequisite for all other courses. It starts off with the notion of Probability, Bayes Theorem, expectation, modes of convergence, strong and weak laws, and concludes with the quintessential Central Limit Theorem.

   The course is the easiest of the courses offered by the Stats department and should be straightforward if one has even a slight interest in Probability Theory.

2) **SI402 Statistical Inference:** This course delves into hypotheses and tests concerning random variables. Likelihood ratio tests, different types of sufficient and complete statistic quantities and various theorems for estimation and inference.

   This course is a precursor to SI422 as it introduces the theoretical concepts needed for regression. The course might have an assignment/small project on construction of a hypothesis test for a real-life estimation task.

3) **SI422 Regression Analysis:** This is the most important and probably the heaviest in terms of the syllabus. SI402 is a soft prerequisite for the course. It starts off with simple linear regression models, then builds on confidence intervals, likelihood ratio tests. Analysis of data for outlier removal, collinearity, residuals, etc. helps in improving the regression model and better fitting.

   The course picks up pace after the midsems since it has a large syllabus to cover. Regularly attending classes and especially tutorials is recommended to score well in the course. Might include a lab component where you have to implement the discussed regression models on small toy data, but dependent on the instructor.

4) **SI404 Applied Stochastic Processes:** Defines Markov processes, basic limit theorems, reasoning about the irreducibility of states, classification. Analysis of different types of Markov processes like Poisson process, birth, death process, stationary process, etc.

5) **SI527 Introduction to Derivative Pricing:** This is probably the most different course from the other four. It gives an introduction of topics in finance: the concept of market,

options, bonds, stocks. Call and put options, American vs. European options, bull-ish vs. bearish strategies, etc. It deals with problems of calculating expected risk, stock price and other factors when dealing with simulators imitating a real market, Black-Schoales model.

There is not much syllabus to cover in this course but the concepts involved are deep-rooted and might be a bit difficult to grasp. Overall the course is moderate, having a good mix of easy and difficult things. The exams are very similar to the tutorial questions.

My Motivation:

Taking a statistics minor is a good idea if you are good at mathematics, inclined towards/worked with probability theory, data analysis and interpretation and related topics. This served as my prime motivation for taking the minor. The minor is mostly theoretical but helps in assuring a deep-rooted knowledge of handling data and making estimations, confidence intervals. It is like a precursor to data science and related domains. In this era of deep learning, it is good to have a solid foundation in statistics which helps you understand data better and apply techniques like residual analysis, covariance tests to ensure you extract as much information as possible.

Even though the courses are mostly theoretical and do not involve practical aspect or coding/implementations, there are many interesting things to be learnt and is surely a highly beneficial add-on to any engineering degree.

Pre-requisites:

The courses assume you have good knowledge of basic probability taught till JEE, and remember most of it. Since the structure of the courses in such that SI417 is a hard prerequisite for all the other courses, it is mandatory to take it as the first course. This along with the limited number of seats means there is a very high CPI cutoff, generally 9+. Mostly students from CSE, Electrical and Mechanical make up the bulk of the batch though it is benefitting for all branches in my opinion. It is a good idea to get on the waitlist while registration (if CPI criterion is not cleared) and request the instructor to approve, which they generally do if genuine interest is seen. Once you get SI417 there should be no problem getting other courses.

The course contents are not particularly difficult but require regular reading and attending classes and tutorials. Due diligence and solving tutorial problems should be enough for any student to do well in this minor and make the most of it.

Misc :

The myths regarding this minor that also make it the most coveted include the boom of machine learning in recent times, high number of non-core jobs in the financial sector, and the relevance of these two aspects with statistics. Though the correlation is not insignificant, it is in most cases

overestimated. Sure, the minor helps build concepts and theoretical understanding that will benefit anyone pursuing any of the mentioned domains, but this minor is not a magic pill which on its own will differentiate you and this should be understood clearly by anyone thinking of going for this minor.

I have stressed this already but attending classes and tutorials is the most important thing to complete this minor. Stay motivated and it surely yields good rewards in the future :D

6.13 KAUSTUBH SRIDHAR - SYSTEMS AND CONTROL

Courses:

The systems and control engineering minor requires you to first do 3 compulsory courses and then pick 2 out if a basket of choices. The first of the 3 (and the first course in the minor) deals with all the math (and only the math) that you would need to work on any system or control problem. The second introduces signals and teaches classical control theory (here is where it gets very interesting). From every machine in any industry to aircraft and rockets, all of them heavily using classical control theory. Further, the next course deals with modern control theory which involves the control of linear and nonlinear systems. This course introduces everything from state space representations to Lyapunov Functions --- all of which form an essential part of robotics and any kind of automation today (from industrial robots to self driving cars and drones in the air or in the sea)

After completing the 3 compulsory courses that basically introduce you to the wonderfully interesting world of control theory, you get to choose among various courses that range from a more robotics side (SC627: motion planning for autonomous vehicles, SC700: embedded systems, etc) to delving deeper into advanced control techniques (SC617: Adaptive Control, SC623: Optimal and Robust Control, SC624: Geometric Control, etc)

My Motivation:

Although a Systems and Control (fondly called syscon) minor would be a helpful addition for anyone in any department wanting to explore robotics, automation and real world machine workings, it would be particularly helpful to those Majoring in Aerospace, Electrical, Mechanical, Chemical , Metallurgical Engineering because of the heavy correlation between their subjects. (Think controlling aircraft, rockets, robots, industrial machines, etc.)

Also, the syscon minor opens up lots of opportunities to do research in robotics and related fields. The minor has also been instrumental in helping me get research internships in India and abroad. :P

SECTION 7 : HSS ELECTIVES - COURSE CONTENT

7.1 HS 301- INTRODUCTION TO PHILOSOPHY

Course Content:

The course will acquaint the students of science and engineering with some issues on the nature and methods of science and mathematics, and the ethical issues arising out of the application of science and technology. The objective is to develop a critical, reflective and historical awareness on issues relating to the following topics:

Topics:

1) **Philosophy and History of Science:**
   Growth of scientific knowledge: Factors leading to the emergence of modern science ; Conceptual evolution: Internal and external history; Methodology of science: Induction, falsificationism, confirmation and probability; Nature of scientific laws and theories: Realism, instrumentalism and underdetermination; Relationship between scientific observation, experiment and scientific theory; Nature of scientific explanation: Teleological explanations and the covering law model.; Selected case studies on scientific theories.
2) **Logic and the nature of mathematical reasoning:**
   Inductive and deductive forms of reasoning; Nature of axioms: Formal axiomatic systems; Concept of consistency, independence and completeness; Nature of rules of inference and proof; Selected examples of axiomatic systems and proof procedures
3) **Cognition:**
   Current approaches to the understanding of mind and mental processes: Empiricist, rationalist, behaviourist and cognitivist.
4) **Ethics:**
   Impact of science and technology on man and society: elements of environmental

7.2 HS 303 - INTRODUCTION TO PSYCHOLOGY

Topics:

1) **Understanding human experience and behaviour:**
   Definition, schools, methods, branches and application of psychology for engineers
2) **Measuring human abilities:**
   Intelligence, Personnel testing
3) **The individual working life:**
   Personality - definition, approaches and theories

4) **Psychological problems of everyday life:**
   Stress and coping, Psychological disorders, Work and mental health, Human learning
5) **Motivation :**
   The concept and theoretical framework, motivating people at work, attitude and work behaviour, group dynamics Intergroup relations, conflict resolution, leadership and management.

7.3 HS 305 - READING LITERATURE

Topics:

1) Nature of Literature : Literature as a Humanistic Experience.
   Definitions:
   - Humanities : concern with culture, values, ideologies;
   - Literature : concepts of imitation, expression, intuition & imagination.
2) Major Themes of Literature : Nature, Science, Selfhood, Love, Rebellion.
3) The Language of Literature : Modes of literary and non-literary expression. The concepts of Figurative language, imagery, symbolism, style.
4) The Forms of Literature : Prose Narratives (short stories & novels) Poetry, Drama and Essays.
5) Discussions surrounding the themes of the pieces being read
6) Reading and reading into (interpreting) a variety of literary texts; analysing the art of literature; evaluation of the context(s) of reading and the reader-text relationship

7.4 HS 307- INTRODUCTION TO SOCIOLOGY

Topics:

1) What is sociology, some sociological concepts: social structure, status, role, norms, values etc. Socialization, and culture and change.
2) Social stratification - various approaches and concept of social mobility.
3) Population and society - Trends of demographic change in India and the world, Human Ecology, Trends of Urbanization in the developing countries and the world.
4) Major social institutions - Family and marriage, caste and tribe and organizations:
   a) Formal organization (bureaucracy)
   b) Informal organization.
5) Processes of social change - Modernization (including Sanskritization), industrialization, environmental/ecological changes and development.
6) Social movements - protest movements, reformist movement and radical movements in India.

7.5 HS 309 - INTRODUCTION TO THE STUDY OF LANGUAGE

Course Content

This course looks at 'language' itself as an object of study which helps us answer several questions about ourselves and our communities, including of course literary expression. We looked at the history, psychology, sociology and structure of language – all languages. Some of the questions we were asked and addressed include:

1) Is language a learned behaviour or an instinct? Is it special to us humans, or found in other animals?
2) What are the special organizational features of language? And how can we describe
3) them?
4) Are human languages different from one another and in what ways? Are some languages more advanced than others? More complicated?
5) How and why do speakers of a given language speak differently? Are human brains special with respect to language?
6) What is the origin of language? What are the politics of language across nations, across sexes, across cultures?
7) Why do computers have trouble understanding/producing human languages?
8) How do we read literary and other texts? How is language crafted in literature? What makes poetry or prose?
9) How do we describe the uses of language such as metaphor? What about humour?
10) Why is learning a second language so difficult? What is an 'accent'?
11) How are mother and other tongues learned by children and adults? What is language death or revival?

Topics:

1) Nature of Literature :
    a) Literature as a Humanistic Experience.
2) Definitions:
    a) Humanities : concern with culture, values, ideologies;
    b) Literature : concepts of imitation, expression, intuition & imagination.
3) Major Themes of Literature :
    a) Nature, Science, Selfhood, Love, Rebellion.
4) The Language of Literature :
    a) Modes of literary and non-literary expression.
    b) The concepts of Figurative language, imagery, symbolism, style.
5) The Forms of Literature :

a) Prose Narratives (short stories & novels) Poetry, Drama and Essays. [Note: 1. Suitable texts are to be chosen by the instructors from the Texts and References listed below as well as from other sources. Use of a Learner Dictionary (Oxford Advanced Learner's Dictionary is prescribed for language work.)]

NOTE: HS 305 and HS 309 sometimes runs alternatively. Students are advised to check ASC>All about courses>Running courses before making a decision.

SECTION 8 : HSS ELECTIVE REVIEWS

8.1 SOM PHENE - HS 301 INTRODUCTION TO PHILOSOPHY

Who was the instructor? What were his policies?

- The instructor was Prof. Amrita Banerjee. Attendance was manual (TAs walk around with the sheets) and carried 10 marks out of the total:0-1 absence were awarded 10, 2-3 absences got 9 and so on. This was clearly announced in the first class itself and a document detailing the entire scheme was uploaded within the first week.
- The class was in LA. Electronic devices were not allowed. Discipline was maintained by having TAs constantly move around. Being a huge class, executing this seemed difficult but except two or three disturbances in the semester, they handled it very well.

How would you describe the course content?

- Plato's Apology (Greece), Dao De Ching and Analects (China) and Katha Upanishad (India) - three Classics were used to cover foundational work in philosophy. I was expecting to see **Plato's Republic** but we didn't see any more of Plato after this in the course.
- Epistemology and Metaphysics: theories of knowledge/ignorance and reality via Buddhism, Advaita Vedanta, Meditations 1 (Rene Descartes) for Rationalism, David Hume's Empiricism, Critique of Pure Reason (Immanuel Kant). In India, although esoteric, this course should include **Jiddu Krishnamurti** just like Advaita Vedanta was covered.
- Moral and Social philosophy, Existentialism : Bentham, Being and Nothingness (Sartre), Simon De Beauvoir and Judith Butler. I was surprised that **none** of Albert Camus, Kierkegaard, Heidegger on Neitzsche were covered. Also Sartre's book was referenced but not covered. This content was slightly non-standard: Instructor drew from her expertise in feminism to include Beauvoir and Butler in covering Existentialism.
- This course needs to have a separate introduction to Propositional Logic and some Set Theory first which was only done vaguely in half a lecture. Those who take the Logic course in the HSS dept. prior to this will benefit a lot as these themes are constantly running in the background but not explicitly stated. Case studies like the recent Facebook's privacy policy fiasco would have made the course more pertinent to the technology oriented audience. Although which particular figures and their writings are used are specific to the instructor, students are expected to see the bigger picture and get hold of the basic ideas and tools that emerge in philosophical thinking. Separate lectures were devoted to similarities and differences in the viewpoints of the philosophers which gives a deeper understanding. It covered enough philosophical classics and major philosophers to give an overview of the philosophical attitude and its methods. This lays a good foundation for students who can then pick up their own topics of interest and take specialized courses in those.The problem

is that mild experimentation to cover topics that are directly impacting engineering students would have been better to satisfy the students' short term mindset but sticking to the standard figures and issues will help them in the longer run.

What was the examination process?

- Midsem (35%), Endsem (45%), Analytical Essay (10%), Participation=Attendance (10%) If one attends lectures and pays attention, objective exams are straightforward application of what's covered in class. If one is not regular in class, studying one night before will require memorizing a large amount of names without sufficient connections. Passage based questions need understanding of the material as the questions are framed such that those trying to answer only based on the passage will get the wrong answer (not all the time, some freebies are always there). In most international universities, the introductory philosophy course includes a large number of critical writing assignments but this course had only one (that's due to the nightmare task of manually correcting so many subjective copies).Topics are given in advance and one has to choose one and write their own analysis of the topic. Word limit is 1000 (references included).

How many study hours were you required to devote to this course? Did it make you feel relaxed or stressed?

- Philosophy is part of life, it is an observation of one's own daily thinking and ideas. I cant find a way to stop that observation. There's no study hours I gave to this course as I had already read most of the works covered in class, three years ago. Listening to lectures and participating in discussions was enough to revive all the memories. No stress at all, In fact I willingly picked up specialized books on certain topics that were not part of the syllabus or those which were not covered extensively due to lack of time for fun reading (Our library has a surprisingly good collection of Indian texts). The instructor and TAs are always willing to discuss topics in and outside the syllabus and I had many such impromptu discussions. Quite a few of my friends faced difficulties with some abstraction and had to devote nearly 2 hours of self study (basically reading the texts) per week in addition to paying attention in class and then we would share each other's viewpoints or argue on some topic.

What were your motivations for taking this elective?

- I've had significant trouble in understanding human existence and purpose of life for last ten years. I shifted my focus on theories of knowledge and reality for the last few years, meditated in the Himalayas, attended two fantastic courses by internationally renowned humanities professors at my exchange prior to taking this course and had also been part of multiple international short films on existentialism. I took this course at a time when I had started to consider philosophy as a possible option for my further studies. Looking back, learning-wise it may have been better for me to choose Sociology as most of the content of

Philo and Psych intro courses would be a repetition for me.

What were your expectations before taking this elective?

- I was expecting some in depth coverage of core Indian Philosophy, and technology related issues in Moral and Social Philosophy as the course is been taking in IITB and many writing assignments. In class, I expected it to be focused on discussions and debates.

How well were the expectations met? Any pros and cons you would like to list?

- The course was quite contrary to expectations in that it didn't give special priority to Indian Philosophy, and had just one essay. No coverage of how philosophy and technology are directly related. There wasn't much room for discussions in class as the instructor spent most of the time in guiding through the main themes and reviewing ideas in the texts. The course managed to cover enormous diversity of figures and schools of thought. Two of the TAs(Danish and Saee) were specialized in Law and Classical Pragmatism respectively, so those interested can talk to them. Professor Banerjee is an expert on Ethics and takes a course on the same next semester.

How does this HSS elective complement your degree?

- Philosophy shouldn't be studied with a mindset of being useful for something else because then one is not studying philosophy but treating it as a use and throw tool. That's one of the key points of philosophical attitude which distinguishes this subject and mathematics in contrast with applied sciences. It complements the engineering degree just like an ice-cream complements a healthy dinner (it's not useful for physical health but people who like it have it anyways).
- Those who want something directly useful, can find such things- Analysis, debating, critical thinking, writing skills will improve significantly, Socrates' comments on the ignorance of engineers of Greece, Dao De Ching's revolutionary concept of how leaders should employ non-action, Rene Descartes philosophical text helps understand the rationalist mind of this Mathematician (Cartesian Geometry is named after him), Causality and Space time through metaphysics, Benthamite Jurisprudence for law related issues, Milton's Social Contract theory, Moral/Social/Ethical issues in technology that will be faced sooner or later. Those interested in spirituality and enlightenment will find Upanishads, Buddhism, Advaita Vedanta, Daoism particularly helpful but do not expect anything without having thought on these questions yourself. It takes 4-5 years of constant self-inquiry to even get to point where deeper understanding is possible. However these applications are very specific and one will miss out on the bigger picture if one tries to focus on these particular things. In fact, there are other specialized courses for application oriented students in HSS and SOM.

8.2 RAHUL MANGLIK - HS 303 PSYCHOLOGY

Course Instructor

Prof Mrinmoyi Kulkarni

Course Overview

This course teaches you about the basics of psychology and how it was developed. It is more of an “inch deep mile wide” approach the professor followed to give us an overview of the various substeams in psychology.

Testing Policy

We had 2 writing assignments, of which one was based on a book which we had to read. Other than that there was a mid sem and an end sem, both MCQ and both mapped to the slides posted by the professor. Attendance was said to be compulsory but it was relaxed in the end.

Material Covered

A course which is supposed to go into the deeper aspects of thinking and how your mind works starts with exactly that, how you brain functions biologically. This is a part which was overlapping with what you studied in school, involves a bit of rote learning but eventually, through the course you understand why this was important and the dots start connecting. The major part of the course involves knowledge about experiments and theories by famous psychologists on some of the most common aspects of life like thinking, sleeping, factors affecting our growth, etc. This is particularly interesting as you can see the development of psychology as a subject. As the course progresses you delve deeper into how the mind functions, how it can be manipulated and what are the levels of satisfaction (needs) one has.

While you may not become capable of mind reading or manipulating after doing this course but you will certainly be better at understanding why do people (and you) act the way they do.

Should you take the course

There is quite a bit of rote learning (1 day) involved if you want to get a good grade and you will have to Google a lot of stuff to get the essence of the material if you haven't attended the classes. Making notes of what the professor says is important for exams as some of the questions were directly from statements in class. That said, the papers being MCQ were logical and you could work your way round most by applying some mind.

Also the fact that the psychologists we are taught about, the likes of Freud, Skinner, Pavlov, Piaget, Maslow, are really well known for their work and knowing about them is something expected from most people should be something you should consider.

This course will definitely bring a new perspective to your thinking with or without you realising it

8.3 ISHITA SHAH - HS 305 READING LITERATURE

While picking literature courses, it is a good idea to go by the professor who's offering the course as opposed to the course content, as the content changes drastically based on the professor.

That said, read on for a bite sized review of the course HS 305: Reading Literature

The professors for the course were Prof. Sharmila and Prof. Suddhaseel. It ran in two halves and both of them prescribed very different texts. While Prof. Sharmila used shorter and more modern texts from various geographies around the world, Prof Suddhaseel read longer and more classical pieces of literature from Shakespeare and Conrad. In general, they employed a lax attendance policy, however most of the classes were highly discursive which implied that attendance was positively correlated with grades and reading of texts a day prior to the exam was a poor substitute for attending lectures.

Literature courses demand regular reading of the texts and participation in discussions, which is also the most enjoyable aspect of it. Regularity in both pretty much ensures breezy exams and quizzes.

My motivation to take the course, was simply a love for literature and an urge to keep reading regularly. The expectation that anyone should have when they take the course, is to be able to explore different kinds of texts from around the world. The kind, that one doesn't generally come across on their own. And then, upon reading, engage in discussions over the texts where personal opinions and questions are welcomed and debated upon.

8.4 ROHAN KAUSHIK - HS 307 SOCIOLOGY

Course Instructor

Prof. Anush Kapadia

Course Policies

- **Attendance:** Don't quite recall what the attendance policy was, but it's impossible to get through some of the course content without attending the lectures. So not going for lectures guarantees a bad grade, if not an FR.
- **Electronics:** Can use.
- **Discipline:** Pretty fair. He will call you out if you're making noise, will stop the lecture if too many people are talking/not paying attention.

Course Content

So his approach to this course is really interesting, he takes you through different thinkers one by one, and their ideas about society and how it functions. He will typically spend 1.5-2 weeks on one thinker, and then move on to the next. It starts with a look at what society in general looks like, and then moves on to the Western societies and their development. In the latter half of the course, the focus is shifted to Indian society and Indian sociologists. It is actually a very intuitive approach, since a lot of thinkers tend to build off of each other's theories/ideas, and you get to see the influence(s) of the thinkers of the previous generation on those of the next.

Examination Process

All quizzes and mid/end semester exams were MCQs. All of them were understanding based, some were comprehension based as well. If you haven't attended lectures, these would be tough to attempt. Many of the options will look/mean the same thing, with subtle differences. You'll have to pick the one that best answers the question'. These will be so similar that sometimes during the post-exam paper discussion, Prof. Kapadia will himself admit that the options are the same, and will accept two (or more) options as the correct answer.

No assignments.

Study Hours

Kinda high, maybe around 4 hours a week. He gives out a lot of study material, including links to podcasts. A lot of these are optional, but I recommend listening to the podcasts. Most of them are BBC podcasts, so you know they're good.

Motivations for taking this course

Needed to finish an elective, and this seemed interesting enough, you know, learning about how society functions, or rather how people think it functions.

8.5 TOSHI PARMAR - HS 309 INTRODUCTION TO THE STUDY OF LANGUAGE

Out of the four options offered at the start of the fifth semester, Languages requires the least amount of rote learning, and is fairly intuitive. It is an extensively logical course in linguistics with objective question papers and thought-provoking insight into the development of English, Hindi and a couple of major regional languages. The last time (session 2017-18) the course was administered by Prof. Vaijayanthi Sarma of HSS dept., and saw the maximum enrollment 62 of students because of a relatively lenient grading by the previous professor (session 2016-17), which is an objectively stupid criteria to take up this course because of the following reasons -

1) There are no official prerequisites for this course, but it presumes a fairly above average level of proficiency in English grammar to begin with.
2) The course doesn't require additional learning but to get a decent grade >80% attendance is required, along with presence of mind, since the instructors often do not mention a lot of detail in the slides and ask questions in every exam from the said part.
3) 10 weekly tests with a total of 30% weightage have to be taken by every student, the tests are easy but are more often than not are based on content that is not in the slides but was discussed in class.

The course is a relatively easy and interesting one, majorly divided into -

Morphology, Syntax, Phonetics, Phonology, Language Acquisition and change, and Writing. There are excellent references for the course which match the instructor's course plan and content very well. If, say, you are interested in Computational linguistics or Natural language processing, both interdisciplinary fields between CS, EE, and linguistics, this is a good course to build fundamentals in the latter. If you are not interested in any of these but are fascinated by the development, similarities, dissimilarities, and vagaries of language, this is a course that holds answers. If none of the above things apply to you but you're looking for an HS course that is mildly-interesting, would not require much rote learning, and would fetch good grades if you just pay the minimum required attention in class, this one is still a safe bet.

SECTION 9 : IR LANGUAGE COURSE REVIEWS

IR language courses are the courses that are offered by the institute for the benefit of students as well as staff of IIT Bombay. These courses are offered in many languages like Japaneese, French, Italian, German etc. The following reviews of four languages i.e Japaneese, Chinese, German and French will help in providing a better exposure to the course and deciding which language to take up.

9.1 SHASHANK OBLA- JAPANEESE COURSE

JAPANESE 日本語 (NIHONGO)

The Japanese Language is strongly derived from the Chinese language. It shares some of the sentence structure with Hindi in the Subject/Object/Verb placement. The writing system has unique elements and is learnt at the beginning: It consists of three scripts: Hiragana – for particles, verb/adjective forms, prepositions, etc. ; Katakana – for words adapted from foreign language; and finally Kanji – directly derived from Chinese, these are characters which have an inherent meaning embedded in them.

Like any other language, the challenge is to learn the sentence structures, grammar, phrases and other minor details. But what adds to the complexity is the different writing system and the fact that there are over 2000 Kanji characters in everyday use and is impossible to learn and use all of them in a short period. For Indians, the pronunciations are quite simple and like Indian languages which have similar phonetics barring a few sounds and hence speaking does not pose much challenge, though listening and understanding might be a challenge.

The US categorized Japanese among the hardest languages in the world for native English speakers but is significantly more comfortable for Asians to catch on.

TAKING THE COURSE-

Why learn Japanese?

There is a multitude of reasons for students to learn Japanese. Some of the common reasons include an active interest in Japanese “Anime” or “Manga”, talking to Shirucafe staff, while others have serious goals such as clearing the Japanese Language Proficiency Tests (JLPT), which are required if you're looking at working in Japan. The course as an end in itself and the certificate given have very little value, and it depends on how you plan to use the learning from the course.

How to register for it?

The course is organized and conducted by the “Office of the Dean of International Relations” along with the other Language courses. For the Beginner’s Batch, every Autumn Semester a form is floated on the Student Notices mailing list around mid-July with classes starting from the first week of August. For the Intermediate Batch, manual registration needs to be done with visiting the Dean of IR’s Office according to the instructions mentioned in the email notice.

Registration involves filling the form/giving your name to the office followed by an online payment at https://surveys.iitb.ac.in which includes the fees for the books and a refundable deposit (given minimum 80% attendance is maintained).

ABOUT THE COURSE-

Course Content-

The course though being quite flexible in what is covered usually follows the books of the series Minna no Nihongo (みんなの日本語) or “Japanese for Everyone” when translated. Apart from the books, the instructor often digresses to cover some general topics, such as engineering/math vocabulary, and the geography and history of Japan as well.

Beginner Batch-

As the script for the Japanese language is different, and there are also multiple scripts with situation dependent usage, the course begins with familiarizing with reading and writing a subsection of the script – the kana (ひらがな and カタカナ). This is followed by some basic vocabulary and then the books. The beginner’s class covers Minna no Nihongo 1, which has two parts; the book is designed for new learners; hence the pace of new vocabulary/grammar is very well designed. Basic grammar such as verb tenses, adjectives and prepositions are included. Completing the Beginner Level provides enough knowledge to take a shot JLPT level N5 though Kanji must be practiced separately.

Intermediate Batch

Being a continuation, it picks up with the next book in the series Minna no Nihongo 2 which covers more advanced grammar and vocabulary. It involves many intricate facets of the Japanese Language such as phrases, expressions, politeness and more complex forms of verbs such as the imperative, passive, and much more. The language being learnt in this batch is very specific and hence requires careful study, but significantly increases the learner’s ability to articulate and express complex situations and thoughts in the language. The instructor also as a side, teaches some of the typical

characters of the more complex script called Kanji (漢字). Completing this level provides close to enough knowledge to take a shot JLPT level N4 soon after.

Class Timings and Structure-

Each batch runs through two semesters to complete a total of 100 hours (50 in each semester). This is divided into two classes per week of 2 hours each during the semester. The classes for the beginner's batch run on Mon-Thu from 5 to 7 PM and 7 to 9 PM as two sub-batches while the intermediate batch runs on Tue-Fri from 5 to 7 PM only. The timings of the Intermediate Batch can be altered upon discussion with the class and if a mutually suitable alternate time slot is available.

Apart from the regular classes, the instructor also plans at least one movie day which involves watching 2 ~ 3 Japanese Movies (with subtitles of course!), a culture day and a house party where he serves Japanese food such as sushi, gyoza, and Japanese Tea. Some standard movies include “ALWAYS

Sunset on the Third Street” (三丁目の夕日), Happy Flight, Okuribito (送り簿と), Otoko wa tsurai yo (男は辛いよ) and some documentaries as well. Culture sessions include Origami, Japanese Tea Ceremony and Japanese Calligraphy (書道).

Course Load-

The language is demanding and does require effort, and merely attending the classes will not be enough. With frequent revision though, the course can be sustained easily; it is equivalent to a 6-credit course, and hence you must factor this in when deciding on the overall semester load.

The course has one exam each semester, usually 1 ~ 2 weeks before the endsem during class hours. Apart from this, an essay must also be submitted each semester which, involves a movie review based on the movies shown during the movie day – 200 Characters for the Beginner and 400 for the Intermediate Batch.

The beginning of the course can be cumbersome to keep up with the material being covered requires significant effort. And the pace is also quite fast, which tends to dissuade many students

causing the thinning the batch in the initial months. But once one has settled into the language scripts and the teaching style, it becomes easier to handle.

Instructor-

This review is about Mr. Chiaki Sunauchi who has been teaching this course for the past four-plus years

He is a capable teacher and can handle the class. He is interested in the students learning the language and their understanding and makes every effort to do the best he can. He is very approachable and accommodating but does not tolerate indolence on the part of the students.

And like most Japanese, he is punctual and sincere in taking the classes and expects reciprocity.

He is very fluent in all the intricacies of the Japanese Language and answers any doubts one might have. The instructor being from Japan means that there is the advantage of learning the language from a native speaker, but this also means that his English is not very strong. He has difficulty in communicating for more than a few phrases in English, which becomes very difficult, especially for the Beginner's Batch.

He also has some trouble with organizing the course content outside of the book, and the content delivered is usually not a smooth flow. He is also forgetful at times, which compounds the trouble.

What do you take away?

Other than what you've learnt in the course, a certificate is awarded noting the completion of each of the 50 hours along with the attendance percentage and a letter grade (A+, A, and so on) based on the examination and essay.

MY VERDICT-

Based on my personal experience and opinion, the language course is an excellent experience and break from the rigorous coursework. It also helps understand a different culture and their practices and gives the ability to interact more comfortably with the Japanese People.

But the course should only be taken if one has a genuine interest in learning the language as that is the only thing that can push you through the difficulties in learning the language and adapting to the teaching style. And given the limited scope of application (only useful to talk to the Japanese or as a foreign language study), taking it solely for fun may not work out if one's determination wavers.

"Koo International Co. Ltd., Japan" and usually carries not much value.

Proficiency must be proven by passing the Japanese Language Proficiency Test (JLPT).

More information about the language courses in general and the Japanese Course can be found on the International Relations Office's website here:

- Language Courses: http://www.ir.iitb.ac.in/?page_id=30
- Japanese: http://www.ir.iitb.ac.in/?page_id=28

9.2 CHINMAY BALIGA - CHINESE COURSE

Mandarin - 普通话 (Pǔtōnghuà)

Nǐ hǎo! Interestingly, the hardest language to learn is also the most widely spoken native language in the world. Mandarin Chinese is also called Pǔtōnghuà, the *lingua franca*. I'm glad to share my review of one of the most rewarding choices of insti life.

I had missed out on the online course registration but was able to do the course registration offline. I visited the IR office, and one of the staff got me enrolled. Later we were supposed to pay the fees and deposit online via surveys.iitb.ac.in. The course (Basic, but not excluding the Advanced batch) runs for an entire year in two modules, each with 50 hours of instruction per semester, so be sure to remain vigilant for the course being floated, subject to instructor availability, early at the beginning of the academic year.

Each module consisted of a Mid-term and End-term examination, the weighted average deciding the grade (Outstanding, Good, Satisfied, Passed, Failed); a certificate is awarded at the end of each semester, subject to meeting a threshold attendance. However, formal proficiency must be proven externally by passing the Test of Chinese as a Foreign Language (TOCFL).

About the Instructor:

Our instructor, Ms Anita Lee (李彩燕), is native to south Taiwan. She is by far, one of the best teachers with whom I have interacted. She has been taking the Mandarin courses at IITB for the last four years. Cheerful and approachable, she puts in a lot of effort to see that her students enjoy while learning; all she expects is punctuality and sincere effort by students. She is affiliated with the Taiwan Education Center (TEC) in India, established by NTHU which awards the certificate.

Why take this course?

My motivation to take the course was simple. I had interned at Zhejiang University in Hangzhou, China, in my third-year summers. Initially, the language barrier and cultural differences jolted me. Nonetheless, I had a great time there. I could have enjoyed to a greater extent had I been able to communicate more freely with my lab mates and the locals. After all, Google Translate can only help you to a certain extent. I was determined to learn the language the correct way, with the appropriate syntax and pronunciation.

With a renewed vigour, I returned home, willing to pursue Mandarin as a foreign language in my senior year - and the efforts indeed paid off.

But I do have to warn you, that the language is not natural for a native English speaker familiar to the Latin script. There exist Traditional Chinese (followed in Taiwan) and the Simplified Chinese (developed in Mainland China). For starters, Mandarin has around 20,000 characters called Hanzi (漢字 or 汉字); if you could interpret about 8,000 characters, you could understand the local news. To complicate matters, pronouncing the tones right is another hurdle. At the end of a year, do not expect to be able to comprehensively translate Chinese Manga that you may be able to get hold off.

Do not get put off, since learning is a continuous improvement process, and the more you learn, the more value is added. The respite is the grammar, which is more relaxed than English. You could think of a sentence in English and translate each word to word and end up with a sentence that sounds 'complete'. If you are genuinely interested, remain motivated throughout the year and attend classes regularly, you can breeze through. I used to look forward to attending Mandarin classes after the monotonic morning classes and afternoon labs.

About the course

The load is similar to an HSS elective - you may not even feel it. It's in the evening slots - Monday, Thursday (5-7 or 7-9) or Tuesday, Friday, depending on Basic or Advanced. The batch size is around 15, which could further reduce after a semester. Our instructor was able to give individual attention to all the students owing to the small batch size. This ensured that those facing difficulty in comprehending concepts could get their doubts clarified at that very instant.

The course content follows the Contemporary Chinese Course Series, recommended by NTNU Taiwan. Over a year, you would cover about 40-50% of Volume I (equivalent to the A1 level of the European system), which focuses on practical daily life dialogue. We were given both textbooks and workbooks to complement learning. What begins as you learning to greet somebody gradually extends into being able to describe your interests, place orders at restaurants, etc. In the first module, we also had a video interview (viva) with a native speaker from Taiwan, which counted towards the grades.

Almost every day you learn something new and exciting. We had a traditional calligraphy hands-on session, where our instructor assigned us Chinese names, and we tried our hand our calligraphy. It was an awesome experience. The learnings were task-oriented and activity based. For instance, we played a card game called '99' to reinforce our numbers in Mandarin. We had a lot of exposure to Taiwanese culture as Ms Lee talked about the local customs and traditions of various festivals such as the Mid- Autumn festival, Chinese New Year, etc. We were invited to the TEC office at IITB to socialise with fellow students and staff over bubble milk tea, a refreshing beverage, and a medley of snacks.

Each Module had one session allotted for a Mandarin movie, including subtitles, of course.

Takeaways:

1. Exposure to a new culture, exotic food, etc. Ability to interact with over a billion additional people.
2. Break from rigorous coursework, platform to hone your soft skills.
3. Making new buddies, including those from other programs and batches.
4. If ever you intend to do business with China, having some command over the language would help you haggle better - trust me!

9.3 MADHAV GUPTA - GERMAN COURSE

I am Madhav Gupta and I have completed the German Language course offered by the international relations in the academic year 2018-2019.

A BRIEF INTRODUCTION OF GERMAN (DEUTSCH)-

German is a language which I felt to be quite similar to Hindi or Marathi (Pronouns and way of speaking). It has the same script as English and has 4 extra german alphabets ä, ö, ü and ß. Speaking German in German accent can be a little difficult for Indians because German is a language which uses throat voices a lot. The German **'R'** is very difficult to pronounce.

The challenge in German is to learn so much grammar. Think about it do you think in Hindi why do you say "mereko **meri** kitaab dede" - english translation "Give me my book". There is a gender associated with the word "Kitaab" right? But why is it **meri** and not **mera?** It is intuitive now right? Consider learning all the genders of all the words in Hindi. It will definitely be a challenge at first but after a point of time when you speak/write/listen and watch, it will get intuitive soon.

Overall I would rate the difficulty of the language as 3 on a scale of 5.

WHY SHOULD I LEARN GERMAN?

There are numerous reasons due to which you would want to learn German. The reason can be as simple as learning a new language having fun learning, making mistakes and being a kind all over again or to boost your profile or learning language because you want to work in Germany etc.

Note: It is not as simple as attaining a working level proficiency in any language and definitely not with this IR language course. At the end of the course you will have knowledge almost equivalent to an A1 certificate certified by CEFR (Common European Framework of Reference for Languages). Generally companies demand at least a B1 level of proficiency. There are 6 levels A1 A2 B1 B2 C1 C2 (increasing order of proficiency from left to right) certified by Goethe Institut.

For me? I loved the free environment I got in the classes and the attitude of the instructor. Make mistakes, try something new, everything was welcomed by the instructor and fellow students as well.

ABOUT THE COURSE-

COURSE CONTENT-

The course covered basic grammatical structure of German. Main emphasis was on making and getting an idea of the structure of German, building vocabulary, how to conjugate verbs use nouns and use change pronouns accordingly.

The books used were Studio d A1 by Goyal Publishers. There were two books for training a dictionary and a vocabulary book all of which was provided by the IR Office. At the end of the beginner batch you will be able to be at a near equivalent of an A1 qualified person.

Note: you need to prepare extra for the A1 exam even after the whole course as the A1 exam is very difficult and needs a lot of hearing exercises as well.

CLASS SCHEDULE-

IR office runs two batches of 20-30 students. The timings of the classes are from 1700 - 1900 hours and 1900-2100 hours on Mondays and Thursdays. There are a total of 100 hours of classes throughout the academic year (50 in each semester). You can adjust/attend the class in 5-7 batch or 7-9 batch if you have missed a class with the consent of the instructor. There were extra classes as well if the instructor wasn't available or in lieu of a holiday.

Apart from the regular classes, the instructor started movie screenings after the first test in the first the first semester for fun and brain soaking. We used to have weekly movies played in the VMCC hall and it was voluntary to attend the movie sessions. These movies were great in understanding the language and culture of Germany. I especially liked the movie Der Himmel über Berlin (The sky over Berlin).

At the end of the first semester the instructor took the whole batch out on a Gullu Snack treat which was awesome! We got to know more about Germany and the culture there, how they are different etc.

COURSE LOAD -

Learning any new language be it German, Chinese, C++ or even texting language norms that will require time, effort, practice and patience to learn. The classes will demand time & effort for and if you are regular with them you will sail through the course. If you leave the course/stop paying attention or aren't regular it will require 2x the effort to catch up to the class.

MY ADVICE: the course is quite easy and medium paced **IF AND ONLY IF** you are consistent and regular with your efforts. I would label this as 4 hours of classes and 1.5 - 2 hours of revision hence a 6 credit equivalent course.

The exams for each semester are 1-1.5 weeks before the end semester exams start. The instructor usually had an alternate date as well for people who weren't able to give the exam on the decided date. The exams were to the point of the course content and with regularity one can sail through them.

HOW DO I REGISTER FOR IT?

The course is organized and conducted by the Office of the Dean of International Relations along with the other Language courses. For the basic batch every autumn semester there is a GPO mail on student notices regarding the same. You have to follow the instructions in the mail and you get registered for the course.

For popular courses like French basic and German basic there are a lot of registrations hence the IR office conducts a test for the students based on simple study material which is provided and then students are selected. For advanced courses there isn't a test, you have to register on a link that the instructor give on surveys.iitb.ac.in. The course fee in my time was 3500 INR and 2000 INR was refundable on course completion, **this might be subject to change.**

NOTE: These courses aren't credited and don't add up to your CPI whatsoever. These courses are year long as well, although you can drop these in between or after one semester (the instructions regarding that would be in the mail)

INSTRUCTOR-

This review is about Ms Palina Lissitsyna who taught this course for the first time this year.

She is really capable, friendly and can make a student understand the content easily. I felt she tries her best to teach and makes every effort to do the best she can. She is very approachable and like the Germans she is punctual & sincere.

She is a native speaker of German language and is extremely fluent in German. I believe this was the best part as we got acquainted with the German language as well. She was fluent with English as well and could communicate very well in English as well. I never had any problem in communicating with the instructor apart from her speaking my name "Madhaaav" :p.

NOTE: The instructor might change for an academic year.

TAKE AWAY FROM THE COURSE?

Other than German proficiency and whatever you've learnt you also get some German values and an idea of their work ethic. You also get a certificate of completion which is issued by **DAAD (Deutscher Akademischer Austauschdienst)** certifying the completion of the course with the grade obtained in the course.

MY OPINION

I can say if your reasons are genuine you can and will learn German and have a lot of fun in the classes. Yes sometimes it might get boring for you (certainly did for me) but after a while it got better. You learn new things etc. I felt this as an excellent break from the usual rote learning courses that I was supposed to do. I would strongly advise to take the course if you have a genuine interest in the course and the language.

MYTHS AND ADVICE-

1) **I'll score an Internship in Germany due to this course:** This is not true at all. Certainly might be an advantage if you have A2/B1 level of proficiency but any company/professor won't take you for a project/job if you know German. Getting to the point where you can use the language in professional settings would certainly take some time. Also. you have to prove your proficiency by passing the A1/A2/B1/B2/C1/C2 tests by the Goethe-Institut.

2) **German is grammatically similar to Hindi -** yes the pronouns and the grammatical structure of the language is similar to Hindi. For example - there are multiple genders for nouns (meri Kitaab [my book], mera dost/meri dost [my friend]) similarly in German (mein Buch [my book], mein/meine Freund [my friend]). If you know how to speak Hindi/Marathi it would help to some extent in learning German as well but not a lot!

3) **Don't Translate German to English -** Very important part of learning any language is to read write and most importantly **feel** the particular language. Yes you can get help in English but you should try and think in the language German.

4) **I will be speaking German like a pro after the advanced course** - It takes a hell lot of time to become fluent in any Language and speak the language flawlessly. After the advanced course you will definitely have a good command over the grammar and the language but speaking flawlessly? Not a question at all.

5) **Keep at it** - It might be boring and cumbersome to do all the exercises and the material that the instructor asks you to do, but I assure you if you keep at it you will be glad after one year and it will definitely get fun learning the language after a point of time.

More information about the language courses in general and the German Course can be found on the International Relations Office's website here:

Language Courses: http://www.ir.iitb.ac.in/?page_id=30

German: http://www.ir.iitb.ac.in/?page_id=24

9.4 APARAJEYA DASH - FRENCH REVIEW

Many of us in insti try out a lot of things apart from the prescribed curricula and co-curricular activities. An obvious way for us to do so is via the various established bodies on campus. These inclinations can lead us to play some sports, pick up some new musical instrument or maybe just dabble in organisational stuff with the tonnes of stuff being done in insti, for better or for worse.

As I meandered about as a fairly clueless but the archetypal 'enthu' sophie, I decided to pursue my old inkling to learn a new language. As I was debating the various pros and cons of enrolling in the usual language class run by the Institute Cultural Council, I came across a mail from the ISIR (that's why, read your GPO regularly, kids). This mail talked about official year long courses in various languages of interest by certified and qualified university and faculty. What follows hereon is a brief description of my experience with these classes, pointers to keep in mind and a general review of learning a new language, specifically French in my case.

The basic procedure:

Usually these courses are offered from the autumn semester over a range of languages which students have expressed a desire to learn. Typically, these would include French, German, Japanese, Mandarin and Persian. More languages may be added and this list might be curtailed on the discretion of the IR office.

There are two courses that run parallel for these languages: Basic and Advanced. Both these courses require 4 hours per week, for close to 13 weeks in a semester, for two semesters. French basic classes ran in two batches of ~30 students: 17:00-19:00 or 19:00-21:00 on Mondays and Thursdays. Again, this information if discretionary.

Some popular languages like French may require you to give a simple test for selection and an SoP. You can enrol in these courses by paying the security deposit (refundable against 80% attendance and 50% credit) and the course fee (refundable).

The IR office provides a certificate at the end of the course (I still haven't received mine but never mind), typically one per 50 hours completed by the University providing the accreditation.

Personal review of the course:

Please take everything hereon with a pinch of salt as this is going to be a highly personal, probably biased, mostly one-sided review of anything and nothing related to the IR courses. Here goes nothing.

Personally, the courses are actually not easy as some people might have you believe. They do require efforts commensurate with a typical six credit course if taken seriously (that goes for any course to be honest). If you are learning a language that also requires a different script from the Roman script then the effort is only increased manifold.

One's experience with the courses is highly dependent on the instructor. Hence, I believe a review of such courses is really only half the story as the instructors sent by the respective embassies keep changing every year.

Basic French was taught by Ms. Indjila Abanour. The classes were made fun by the instructor and special focus was given to pronunciation and working fluency of the language. This focus, I believe, went a long way in fitting in the very basics of the language into the students. Additionally, there were interesting assignments that were handed out to make the learning more engaging.

What to keep in mind?

They say, if you take out an Italian word from a Spanish word and spell the rest of it, you get a French word (yes, I made that up). French is a fairly easy language to learn if you have a decent proficiency in English. Fun fact: Close to 30% of words in English are directly derived from French. So, one already knows much of the vocabulary going into the course.

The major hurdle that one faces once they start learning French is the absolute pain-in-the-backside pronunciation of words. Yes, the alphabet is almost exactly the same. Yes, the letters sound individually the same. The fun (or not?) begins when the letters get together. There are more than two dozen (creative liberty) rules of pronunciation that one has to get correct from the get go. Listening to simple French songs really helps (it makes you sound cool too). There is absolutely no meaning moving ahead in the course if you do not get the pronunciation part correct from the start because your instructor is definitely going to start using French more often as they move ahead in the course. I would recommend burning the midnight oil for this.

Once you have the pronunciation sorted, the rest of the journey should really be mostly a smooth ride. There are no inordinately long words like German or a script that no one can make sense of like in Mandarin. French has its idiosyncrasies, obviously. The numbering system is absolutely hilarious and you might have a laugh or two in the class during the same. Reading time is another exercise in patience and frankly, banging your head against the clock.

French grammar is similar to English for most part of the Basic course. There are certain differences which you may find in the higher levels of competencies if you choose to continue learning French. There are two genders, three persons, three major tenses (there are subdivisions) and singular and plural forms. There are the usual infinitives, gerunds, participles and verb forms. As a matter of observation, we usually take the tenets of grammar for granted – it would really help to brush up your English grammar before you dive into the foreign world of French grammar that's oddly similar.

General tips and concluding remarks:

Please please and I can't stress enough on the last please – make notes. One can not learn a language without notes. There is a lot of new words, diction and phrases that you will come across that you will not be seeing in the course workbook. That kind of content can *only* be delivered in class and needs to be documented.

Be regular with your coursework and be actively interested in learning not just the language but also about the French culture. The IR office language courses provide us with a wonderful window into the culture of the respective countries/regions and I would advise one to grab it with both hands.

Audio-visual media is a great way to learn the actual pronunciations and mannerisms of speaking a language. I would recommend YouTube videos of Indila and Stromae as great starting points for pronunciation familiarisation. Those are also great songs, by the way.

Lastly, there are no benefits to learning French. The only fathomable reason why one would take up the course unless one is interested in learning about France and the French or if one is planning to take up an internship/semester exchange in a French speaking country. Please do not take the course if you are not really interested in all things French and waste your time, energy and your parents' money. Not to mention, take up a seat that could have gone to someone way more enthusiastic than you are.

Lastly, have fun! Learning a language should never feel like a chore. Have a great time, God knows I did. If you feel like a French libertine marquis who sips his Chardonnay as his hors d'oeuvres arrive crystal chalice, you are on the right track. If, however, you pronounced all the letters in the previous sentence, you clearly are not :P

SECTION 10 : COURSE LADDER

We come across many fields like machine learning, AI, finance, analysis etc which don't have dedicated degree programme in our insti. So how to proceed further? We bring a new initiative, "Course Ladder", which acts as a step-by-step guide for all those who want to pursue a career in these fields.

10.1 ANALYTICS - RAHUL CHANDUKA

Hey! I'm pursuing a field called quantitative analytics (the role is often shortened to quant). It involves designing and implementing models to price financial instruments (typically securities). It's a place where Finance and Analytics go together. While I'm still not fixated on the field, this has been one of the most intellectually challenging things I've explored; and to be honest that's something that has kept me going!

Motivation

Books like 'Liar's Poker' and movies like 'Wolf of Wall Street' tend to get your attention :P

If I write about things that I think pushed me here they'll probably be full of hindsight bias, so I'll just stick to facts. I love numbers in all forms! I relish uncertainty, and as you would expect Probability is one of my favourite mathematical constructs. My interest in "black swan events" (If Finance is chemistry, then black swan events are 'exceptions'!) has also kept growing over the years. I enjoy mathematics; Linear Algebra and Calculus are among my favourite topics. Add to this an interest to do technical research and the curiosity to explore datasets, and lo and behold, you have a quant enthusiast!

My Path

I've deviated a lot from where I first started. I tried Machine Learning in my first year from resources available online and enjoyed it. I became the Analytics Club Convener in my second year hoping to gain from interactions with industry personnel. I had a course on economics in my third sem, and while it messed up my SPI, I enjoyed the graphs and interdependencies of the many variables. Motivated by the same, I reached out to an economics professor at IIM-A for a winter internship and luckily he responded positively. With the prof. I did some work on computational economics and developed an interest in the working of stock markets. Towards the end of the winter break, I was exposed to an online quant training program (Auquan) and signed up for it. After a couple of screening rounds, I was selected for the same; and the training involved

creating algorithmic strategies for investing. These ranged from simple intuitive strategies to complex data based decision making. I learned a lot, and had fun too! With 2nd year summers incoming, and implicit pressure to get an internship (I didn't want one tbh), I signed up for a summer workshop (30 day long) at CMI (Chennai). The workshop, titled "Maths and Finance" had ~20 people from all over the country. We had lectures 5 days a week, both on mathematics and programming. I made some amazing friends there, and had a lot of fun (alongside work :P)! In my 3rd year I was part of the first ever Data Analytics and Visualisation(DAV) team of the institute, where I learned a lot about handling real datasets. Fast forward to the present (my 3rd year summer), I'll be interning at WorldQuant Research (Hiranandani), and will be heading the DAV team next year! You should notice that after the first step it was all about perseverance and continued interest; and I think that that's all that matters in any field.

Courses

Most of the courses I did in the institute did not directly influence my quant skills but rather satiated my interest in Probability theory. I'd recommend a basic course on Probability theory (if it's not a core course), maybe **EE325**(CPI shouldn't be a barrier in the even sem) or **SI417** (odd sem, very high CPI cutoffs). I've also heard about **IE502** from batchmates.The freshie courses, namely Linear Algebra and Calculus are very important for the field.

If you want a tech role in the future, some Computer Science skills come handy. I'm pursuing a minor in CSE, and courses like Data Structures and Algorithms(**CS213**, CPI cutoff of ~8.5, look out for prof. Ranade taking the course; he had allowed anyone to take it with a strict 80% attendance constraint) and Intro to ML (**CS419**, CPI cutoff of ~8.5 again :\ ). I suggest you do the courses in the order specified, CS101 followed by CS213 and then CS419.

Apart from these, I have done some IEOR courses like IE611 and IE613 (no CPI cutoffs). Both of these require some basic probability course as a hard prerequisite. They're not essential, I did them just to satisfy my hunger for applied Probability. My seniors have recommended the course Financial Engineering (**IE612**) but I haven't done it yet.

A stats minor may also suit you, please have a look at some reviews of the .

Other Resources

Both Finance and Analytics have a tonne of resources available on the web. With Finance, Investopedia should probably be your go to place. For analytics, there are amazing courses on Coursera that come handy. I've personally done the following courses:- Financial Markets by Yale, Financial Management by UIUC, Intro to Business Analytics by UIUC, Machine Learning by Andrew NG. I believe that the best way to learn analytics is by application. You may want to search Kaggle for some cool datasets to try out things you learn. Some books like "Fooled by Randomness", "Liar's Poker", "Barbarians at the Gate" should also be part of the "learning" since motivation is a must in quant, and these books are the ones that have rejuvenated me when I start to lose interest/hope. They're not good indicators of the modern financial world, but well, they'll certainly widen your imagination!

Tips

The field is still new, and pretty complex for an outsider. I suggest you keep someone as your go-to person so that you can approach him/her in case of doubts and/or lack of motivation. I didn't have that, and if I could change one thing I'd probably change that. It's easy to get lost in the myriad of resources, without realising what's best for you. It is also important to stay motivated, since you'll find people better than you all around. It's a challenge intellectually, but in my experience perseverance tops everything else.

Finally, if you are aiming for campus placements in the quant sector, do keep a presentable CPI. Most quant roles have a CPI filter during internships and placements. Keep your explorations to a level where your core curriculum is balanced alongside. The summer and winter breaks are havens for exploration. Coming to internship tests and interviews, most of them involve questions on application of probability theory (puzzles of sorts). While it may not have a lot to do with your job, it's actually a pretty good metric to gauge intuitive understanding (in my opinion)

Good Luck and Keep Exploring :D

10.2 ARTIFICIAL INTELLIGENCE - ARKA SADHU

This "Course Ladder is based on the blog https://theshadow29.github.io/AI-Course-Selection-IITB/

1) **Basic Machine Learning Course**:
   This is the foundational course on Machine Learning. There are two courses CS 403/725: Foundations of Machine Learning by Prof. Ganesh Ramakrishnan and another EE769 Introduction to Machine Learning. I took the former course (CS725) at the start of my fourth year (7th semester), and haven't taken the latter. This is a foundational course but requires decent amount of comfort with probability. I would suggest taking this anytime after you have done a course of probability (for EE students it would be after EE 223 which is core course to be done in 3rd semester). Perhaps a good time would be 5th or 6th semester otherwise one might often miss out on appreciating many details. The course typically comes with an open ended project and I highly suggest trying to implement a research paper. Broadly it covers supervised learning and some parts of unsupervised learning. The course is fairly math-heavy and gives gentle introduction to linear regression, support vector machines, classifications, neural networks, bagging and boosting. Quite a few things are non-intuitive. Luckily the Professor has all this in video lecture format and you can review them once at home. There are also regular quizzes to keep you grounded.
   Do note that there is a newly introduced minor for the Machine Learning course(CS - 419) in the CS department and accordingly CS725 might be restricted to graduate students and for UGs taking the minor course would be the only option. Please check with the department for course offerings.

2) **Advanced Machine Learning Course**:
   This a course in the CS department CS 726: Advanced Machine Learning offered by Prof. Sunita Sarawagi. I took this in my 8th semester. I don't feel there is need to do a Basic ML course before doing this if you have done similar course online or worked on any relevant project. However, prior knowledge and understanding of neural networks, cross entropy loss etc are a must. The course starts by introducing Graphical Models in the first half. The second half comprises of neural networks and in particular delves into the cutting edge research topics which are actively being developed and I think the course content is pretty fantastic. This too comes with a course project and one can explore quite a few domain areas. I would suggest not taking this course unless you are fairly familiar with neural networks and have at least some coding experience with them

otherwise the course project will be extremely difficult. A good time would be 6th semester if you have done CS725 and have good coding experience or 8th semester.

3) **Foundations of Intelligent Learning Agents**:
CS 747: Foundations of Intelligent and Learning Agents is an extremely important course offered by Prof. Shivaram Kalyanakrishnan. It starts out with the Bandit Problem, to Markov Decision Process, then gently introduces concept of reinforcement learning till midsem. Post midsem is mainly a broad coverage of wide range of topics. This too comes with a project and the professor expects some novelty in the work which is a good way to explore a particular topic. The professor doesn't allow a third year student to take the course, so the only option is to take this in the 7th semester like me.

4) **Computer Vision**:
There are two courses for computer vision one in the CS dept CS763: Computer Vision by Prof. Arjun Jain and the other in EE dept EE702: Computer Vision by Prof. Subhasis Chaudhuri. I have only done the latter one. EE702 doesn't cover the deep learning module for computer vision and focuses on classical vision techniques. CS763 instead focuses mostly on the deep learning part since it gives state of the art results and spends some time on classical techniques as well. I took EE702 in my 6th semester and the prerequisite would be solid understanding of signals and systems and probability theory and of course some maths. In some sense EE702 doesn't fall into the category of AI but it is a good course to do. 6th semester is an ideal time to do this course.
The following is a short review by Parth Kothari for the course CS 763. I will put it down verbatim. This course makes a decent attempt to blend the content of classical vision as well as Neural Networks related Vision into its curriculum (In Stanford, two separate courses are taken to cover these two huge domains). As a result of the combination, the course becomes a little heavy but gives you a really good idea of what existed pre and post NN era. Just like the other CS courses, the main learning happens through the assignments (there are 6 assignments in the course) and I would strongly urge to focus on them and not just on the theory. If ever you feel like giving computer vision a chance, please take this course seriously and not just let it pass away as yet another ALC course especially if you are a newcomer into the world of Vision. If you want to dig deeper, a great follow-up of this course would be to do the assignments of the equivalent course of Stanford (CS231n). They are wonderfully prepared and

many of the questions explore the recent trends in the NN driven Vision domain. There are a couple of related courses to computer vision. While the coursework is completely different I will mention a few courses which complement Vision courses.

a) **Digital Image Processing**:
Again there are two courses one in the EE dept and the other in CS dept CS 663: Digital Image Processing. The CS course is jointly taken by Prof. Suyash Awate and Prof. Ajit Rajwade. I can vouch for the CS course in that it covers many fundamental topics. The second half of the course is especially useful as it covers a very wide range of topics like Face Recognition, JPEG compression etc. There is also a course project involved and you have plenty to learn. I took this course in my fifth semester. And I would recommend taking it around the same time.

b) **Advanced Image Processing**:
This is a course in the CS dept CS 754 - Advanced Image Processing. It covers a broad range of topics like tomography, compressed sensing, dictionary learning etc. While quite a few of them are not very relevant from AI perspective, they make a fine addition to the list of interesting courses you could do. I took it in my 6th Semester.

c) **Medical Image Processing**:
This is also offered in the CS dept CS 736: Medical Image Computing. I haven't taken the course and the review is by courtesy of Parth Kothari. I will put it down verbatim. This course explores the math that goes into advanced image processing applications. The best way to describe this course is a math-ier version of CS 663. Medical field is just an application of the theory taught in the course, so don't fall into the trap of thinking that it has only medical applications. Because of the rigorous math involved, it might get a little tough to get along liking the course but personally, many of the core statistics and ML concepts are nicely taught in the course and the slides are really good to revise in your room. If you are up for some theoretical stuff related to IP (in contrast to the CS 763 NN module), this is the course for you. In this course, I found learning the theory much more important in comparison to doing the assignments.

5) **Speech Recognition**:
Similar to Computer Vision, there are two courses one in CS dept CS753:

Automatic Speech Recognition by Prof. Preethi Jyothi and EE679: Speech Processing by Prof. Preeti Rao. While the former focuses on advances in automatic speech recognition, the other focusses in general speech processing and the two have very little overlap. I have only done the former (CS753) course in my 7th semester. Basic ML is again recommended but not compulsory. It covers the basics of automata theory, to Hidden Markov Models and introduction to language models till the midsem. The latter half is mainly a tour of neural networks applied to speech recognition and there were a few lectures devoted to speech synthesis as well. The course expects a strong background in probability theory and while it covers basic of Neural Networks it expects a decent level of comfort with them. The assignments are fairly interesting and have both a theory and a practical component. A good thing about the course is the course project starts fairly early which gives the opportunity to explore variety of things. I would recommend taking this in 5th or 7th semester.

6) **Optimization**:
This is the broadest of all topics. There are a large number of courses centered around this in different departments. I am linking 3 of the courses I know.

   a) EE659: First Course in Optimization by Prof. Vivek Borkar:
   I did EE659 in my 7th semester and it is one of the most math heavy courses I have ever encountered. In theory, you don't need probability theory to do this and can ideally be done in 5th semester as well. The only reason I would not recommend doing in 5th semester is that it is usually quite loaded and this one requires more concentration than you can imagine. I had a blast doing this course. It supported many of the intuitions that I had developed over the time I had developed in doing computer vision and machine learning stuff. There were 3 quizzes each and no midsem or endsem and the quizzes were easier than what was taught in the class. It starts off with the Bolzano Weistrauss Theorem and uses it as a base to teach all of the Convex Optimization, goes to different methods of Convex Optimization giving a flavour of Non-Convex optimization as well. Concludes with distributed optimization but those are not in the exams.

   b) CS 709: Convex Optimization by Prof. Ganesh Ramakrishnan :
   I haven't taken the course and the review is courtesy of Kalpesh Krishna. A substantial time was spent on pre-requisite stuff (linear algebra MA106

level) and it was difficult to follow the Professor at times. Also, the course content is a bit weird in that the most useful content was covered in the last month. The project is a good experience and involves a paper implementation. Assignments were a bit random though. Exams on the other hand were very well thought of and on the harder side. Unfortunately class attendance was generally on the lower side. Kalpesh took the course in his 8th semester.

c) SC 607: Optimization by Prof. Ankur Kulkarni

7) **Information Retrieval**:
I am adding this for completeness but since I haven't taken this course I cannot really add anything. It would be a good idea to look at the course content. From what I have heard (courtesy of Siddhant Garg) it is a pretty good course and a very important topic in CS. There are two courses a Basic and Advanced course both taken by Prof. Soumen. It covers a broad range of topics relevant to Web Search, Information Retrieval and Natural Language Processing.

8) **Natural Language Processing : CS 460**
The course is taken by Prof. Pushpak Bhattacharyya and it runs occasionally. Keep an eye out for this. Unfortunately I wasn't able to do this course during my stay.

9) **Math Courses**:
It is a good idea to have a strong base in Mathematics if you want to do anything in AI. There is no doubt that the amazing libraries like Keras and Pytorch make it extremely easy to code, most papers require you to understand some basic maths. Here are some of the courses which I think are quite useful.

a) **Real Analysis**:
Real Analysis is a course in the Maths department(MA403 : Real Analysis) and compulsory course if you want to get minor in Maths. For EE there is another course called EE759: Applied Mathematical Analysis In Engineering. I have taken EE759 and it is an amazing course taken by Prof. Debasattam Pal. He teaches every concept very gradually and takes time to deliver the subject. It clears up many misunderstandings one might already have and paves path for all the future AI courses. I took this course in my 7th semester, but this can be easily done in the 3rd or 5th semester as well.

b) **Linear Algebra, Differential Equations and Matrices**:
MA106, MA108 also suffice for most cases. There is a course on EE636: Matrix Computation by Prof. Harish Pillai. Not at all compulsory but does provide a nice base to cover. Most importantly, stuff like Matrix norms and Eigen Value and Singular Value decomposition are taught in great detail which are kind of fundamental to all of Machine Learning. I took this in my 4th semester. Definitely helped a lot with what came latter.

c) **Probability**:
As earlier stated probability is the main pre-requisite for almost all of the courses. Every department has their own version of Probability course and mostly they are core courses. For EE dept there are two courses being EE223: Data Analysis and Interpretation and EE325: Probability And Random Processeswhich are core courses. Pay extreme attention to these courses as it will pay off in the long run.

10) **Research Projects**:
I highly encourage and recommend students especially in their 3rd year to take a RnD project. It is an extremely important learning experience which can boost your confidence. It further helps you in deciding what you want to do in the future, if the research is at all what you want to pursue. It is a good idea to contact professors early on and schedule a meeting with them to discuss if they are willing to give you a project. Make sure to be open minded when discussing projects and try to communicate with the professor frequently.

10.3 FINANCE - DHEERAJ AGARWAL AND NAMAN GOYAL

Courses

Our institute does not offer many courses for undergraduates in finance as of now. Most popular course for finance among undergraduates is Finance and Accounting (MG-403). This high-in-demand course has received good reviews from the students owing to the experienced faculty who teaches it. This course is quite basic in nature but is a good course for someone who has no idea about the field. Then there are some courses from IOER department which are more rigorous in nature like Introduction to Financial Engineering (IE-612) and Time Series Analysis (IE-692). The former course is quite good and will give you an introduction to quants while the latter course will equip you with a particular technique used while analysing stock charts. There is no particular order for doing these courses as all these are introductory courses about different topics but still I believe that MG-403 should be the starting point before moving to courses like IE-612 unless you already have some knowledge about basics.

Apart from that I believe there are quite a lot of resources available for anyone who is interested in this field. I found Varsity by Zerodha as a best introduction guide starting with the basics of stocks to technical analysis, fundamental analysis, derivatives, currencies and commodities as well. The content is very well presented and explained in a way that students from any background can get it. Each module starts with assuming you have no knowledge about the topic and in the end will leave you at a much more comfortable space about the same. I strongly recommend anyone who want to start with finance to go through it. People should also explore websites like Investopedia which has a very detailed explanation with illustrations for all the jargon in the field of Finance.

Certificates

There are many recognised certificates offered for finance by financial organisations. Most popular among students are FRM and CFA. If you are genuinely interested in the field and want to explore this field a bit further, I would suggest to go through these tests which are viewed in high regard and will act as a very strong push and a distinguishing factor, if you want to join the field. FRM(Financial Risk Management) focuses specifically on risk management and can be pursued by anyone who have cleared 12th standard. Preparing for each level takes 40 days and hence students can prepare for it in their vacations. Adding this to your resume will open up many opportunities for you in risk management space. CFA is the most sought-after certification and is considered to

be one of the most difficult and respected exams in financial industry. Unlike FRM, CFA covers all major aspects of finance and this makes the syllabus very wide for this exam. There are 3 levels of increasing difficulties and one needs to be in final year of their undergraduate program to be eligible for it. There are other organisations like BSE & NSE which run smaller courses for students to complete and get certified.

Internships/Projects

Doing an internship/projects can give you a lot of exposure and insights about the field. We have 4 professors of Finance and Accounting in our institute and you can approach them for projects in the field. Prof. Piyush is a new addition to the list of professors and he is most enthusiastic to give projects. You can also apply and approach professors from IIM's and ISB's to ask them for projects during your vacations.

There is a vast majority of financial firms in Mumbai but very few of them visit our campus for recruitment in the field of Finance. Those which come (Standard Chartered, Deutsche Bank, HDFC Life etc), look for basic knowledge in Finance and strong grasp on aptitude. People tend to apply off campus as well to Investment Banks, Commercial Banks, Venture Capitals, Hedge funds etc and the experience is very enriching in terms of exposure to Corporate life and the learning Finance.

Miscellaneous

While there is a lot of things to do in finance, I believe one of the most important habits to develop is of reading a financial newspaper daily. You may find yourself struggling with few terms and concepts in the beginning but just google them up and believe me that after some time reading it will be the most joyful time of your day. Our library provides you access to lots of good financial magazines and newspapers. The insights you will develop from reading them will also be helpful in cracking financial firm interviews.

Clubs/Activities

Then there is a club in our institute dedicated to this particular field(viz. Finance Club) which organise lots of events and competitions related to finance. You can be a part of that and can approach managers in case you are facing any doubts or difficulties regarding the topic. There are many seniors associated with the club who are into trading, investing, investment banking and a lot more.

SECTION 11 : EQUIVALENT COURSES FOR CLEARING BACKLOG

For the purpose of clearing backlogs, a list of equivalent courses which can be done has been given below:

It is to be noted that these courses are not equivalent by default but due to the similarity in the course structure, they have been allowed to be taken in lieu of the corresponding backlog courses subject to approval from the Faculty Advisor and HOD of the concerned HOD's. Approval needs to be taken from the DUGC for tagging two courses as equivalent that are not given in this list.

Backlog	Equivalent Course
ME 346- Heat Transfer II	CL 246- Heat Transfer
MM 152- Materials & technology	CL 346- Material Science
CE 201- Solid Mechanics	CL 231- Solid Mechanics
CE 201- Solid Mechanics	ME 201- Solid Mechanics
CE 205- Fluid Mechanics	ME 203- Fluid Mechanics
CE 221-Solid Mechanics	ME 201- Solid Mechanics
AE 460-Heat Transfer - Aerospace Applications	ME 346, Heat Transfer II
AE 102-Data Analysis and Interpretation	MM 217-Data Analysis and Interpretation
CL 202-Introduction to Data Analysis	EP 219-Data Analysis and Interpretation
AE 102-Data Analysis and Interpretation	ME 102-Data Analysis and Interpretation
AE 209-Solid Mechanics	ME 201-Solid Mechanics
AE 102-Data Analysis and Interpretation	CS 215-Data Analysis and Interpretation
EN 206-Power Electronics and Machine	EE 222-Electrical Machines and Power Electronics
AE 308-Control Theory	EE 302-Control Systems
ME 346-Heat Transfer II	AE 460-Heat Transfer - Aerospace Applications
MM 203-Mechanics of Materials	EN 211-Mechanics of Materials
EN 201-Basic Electrical Engineering	EE 111-Introduction to Electrical Systems

MA 214-Introduction to Numerical Analysis	CL 244-Introduction to Numerical Analysis

The statistics courses of various departments are: AE 102, CS 215, EE 223, EP 219, ME 102, EN 207, MM 217, and CL 202 (8 credits).

SECTION 12 : CONTACT INFORMATION

In case of any queries please feel free to contact the UG academic council members, their contact details are as follows:

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