TEQIP CONCLAVE OF EDUCATORS

On Quality of Delivered Academics in
Mechanical Sciences.

A REPORT

(Held on 22-23 December 2012)

Indian Institute of Technology Kanpur



PREAMBLE

The goal of the workshop was to bring together faculty from the institutions in the local quality circle in the vicinity of IIT Kanpur. In order to keep discussions and interactions focussed, faculty in the discipline of "Mechanical Sciences" – from departments of Mechanical Engineering, Civil Engineering, Aerospace Engineering, Production Engineering etc. were invited to the discussions. Twenty institutions participated in the workshop which included several NITs, engineering colleges of Universities, State Engineering colleges and private engineering colleges. The colleges are institutions supported by TEQIP funding, lying in the region of Uttar Pradesh, Haryana, Uttaranchal, Chattisgarh along with Jadavpur University and Bengal Engineering College, Sibpur. The workshop had about sixty participants from outside, and about twenty faculty members from IIT Kanpur. Representatives from MHRD and NPIU also attended the workshop. Experts from five IITs – Delhi, Hyderabad, Bombay, Madras and Gandhinagar actively participated in the workshop and provided invaluable advice and guidance.

The two-day workshop was a first attempt to make faculty, in a broad area of specialization, to come together to discuss the whole spectrum of academic activities at their respective institutions. Each institution has its own approach to delivery of education, constraints, experiences, and student group. It was desired to look at the undergraduate curriculum, Master's program and PhD programs in entirety and reach some broad consensus on the minimum content and standard desired for each of these academic programs, across all institutions in the local quality circle. The desire to enhance quality of technical education can be fulfilled only through an understanding of best prevailing practices and measuring individual institutional performance with respect to these practices.

The workshop was divided into sessions, with the first day dedicated solely to undergraduate education, and the second day dedicated to Master's and PhD programs and faculty advancement and research. Further, each day was divided into sessions (detailed schedule attached as Appendix I) – with each session focussing on a specific issue. Each session was initiated by a presentation by a concerned faculty from IIT Kanpur. The presentations provided the framework within which the ensuing discussions were conducted. This made the sessions interesting, and the discussions intense. From the detailed discussions, several very important points emerged. These are summarized below.

SUMMARY OF OUTCOMES

The key outcomes of the workshop can be summarized under the following heads:

(1) **Undergraduate core program**:

(a) Rigorous training in mathematics, with stress on depth of knowledge along with breadth. Application (and modelling) should be emphasized through participative tutorials (engineering faculty conduct tutorials) and additional department specific modelling courses.

(b) Science courses should help inculcate scientific temper.

(c) Physics should teach fundamentals with a good mix of demonstrative and hands-on experiments.

(d) Humanities and social sciences have to be an integral part of the core program, to train students on social and economic relevance of technology and technologists and to make them better citizens.

(e) Quality of faculty in core science and humanities and mathematics is an area of concern in most colleges.

(f) Need to develop and maintain state-of-the-art core laboratories in the areas of physics, chemistry and even languages.

(2) **Engineering Science and Technical Arts courses**:

(a) Material science, thermodynamics, fluid mechanics, solid mechanics and dynamics are fundamental to mechanical sciences and should be taught effectively.

(b) Many institutions have a bias towards thermal science and design, which has led to inadequate attention to important courses like dynamics and fluid mechanics.

(c) Fundamentals are often sacrificed in favour of formula-driven learning – leading to lack of perspective and restricted learning outcome. Examination oriented learning has to be relinquished in favour of fundamentals based learning.

(d) Simplistic approach to topics has to be avoided – vectors and tensors based approach should be encouraged.

(e) Laboratories for computing courses, electronics, electrical engineering, material testing and technical arts (technical drawing and workshop practice) should be developed and maintained at levels comparable to IITs.

(f) Examination system should be reviewed – questioning towards testing of fundamentals via a quantitative analysis (more probing numerical).

(3) **Departmental core**:

(a) Some courses need to be mandatorily taught to all graduates of a given department in the engineering science discipline. This should be a mandatory requirement for all institutions.

(b) A more focussed meeting of experts from specific discipline must be called to fine-tune the list of mandatory courses, their content, projects, examination pattern, etc.

(c) Standardized list of laboratory experiments should be developed for TEQIP institutions (again by an expert group, with the help of the local IIT), along with laboratory manuals, animations and recorded experiments for demonstration.

(d) Technical manpower training and faculty training for handling of advanced and basic courses, and laboratory equipment and experiments, should be encouraged for the TEQIP institutions. IITs can provide the desired training.

(e) More varied elective courses need to be offered.

(4) **Post-graduate programs**:

Master's program:

(a) The consensus was for a course intensive Master's program – with sufficient number of diverse courses, pitched at a post-graduate level comparable to the best institutions. A model could be three semesters of course-work followed by one semester of project work, with competent and open assessment.

(b) In case an institution opts for a thesis based Master's program, a thorough review of the thesis quality is required, through external examination by a centralized pool of experts indentified by TEQIP.

PhD Program

(a) Thesis examination should have more probity – adopt norms similar to IITs.

(b) Have mandatory course-work for PhD program – preparing faculty of the future. We recommend separate smaller meetings to decide upon these mandatory courses.

General recommendations:

(a) Knowledge of mathematics (differential equation, linear algebra, calculus, vectors and tensors, etc) has to be strengthened at the Master's level through advanced mathematics course offered by the department.

(b) Research infra-structure has to be enhanced with TEQIP support, input from the faculty and advice of experts (e.g. IITs).

(c) Plagiarism is a concern and should be prevented with proper education and checks.

(d) Encourage collaborative research (through joint guidance) with IITs, NITs to enhance quality of research.

(e) Provide support to post-graduate students to attend national/international conferences/workshops/schools.

(f) In order to facilitate teaching of a sufficient number of post-graduate courses at the requisite level, faculty from TEQIP institutions should be encouraged to take similar courses at IITs/IISc. This will help develop expertise to handle such courses at their parent institutions.

(g) In order to encourage scholarship and collaboration, TEQIP should create scholarships to enable bright post-graduate students to visit IITs/IISc for a semester.

(5) **Functional constraints**:

(a) Streamline purchase processes – centralized rate contract based purchase, lesser local impediments through bureaucratic hurdles (e.g. role of purchase officer or Director). Enable effective utilization of fund, with a proper external monitoring mechanism.

(b) Remove superfluous constraints on hiring process – e.g. all degrees in same branch, NET qualification, arbitrary age constraints (e.g. of 35 years at NITs), etc. Hire aggressively.

(c) Encourage openly advertised and continuous recruitment from variety of specializations – gives more diversity to the program.

(d) Follow IIT recruitment norms, and encourage recruitment of faculty with PhD.

(e) Support quality improvement for faculty through TEQIP fellowships, scholarships, grants for doing PhD/postdoctorate at IITs/IISc.

(f) Set system in place for support to faculty to have active collaboration with IITs through vacation term visiting faculty positions, sabbatical leave, short-term visits – all sponsored by TEQIP grant.

(g) Encourage faculty at NITs to get post-doctoral experience.

(h) Create knowledge repository to which each faculty can contribute and which can be used by faculty as knowledge resource pool. In particular, a repository of course-files (curriculum, examination papers and model solutions) should be made available for each course taught at any TEQIP institute.

(i) Encourage writing of top-quality, relevant technical books (even in vernacular languages) with collaboration of IITs/IISc.

(j) TEQIP sponsorship to faculty and technical man-power to visit IITs for knowledge enhancement, learning to use new experimental equipment and conduct of experiments.

(k) Encourage research through support to present papers at international/national conference or attend workshops/schools. Incentives for writing articles in reputed journals.

(l) Encourage TEQIP institutes to fund seminar series by leading experts in a relevant subject area. Also facilitate visits of faculty from reputed institutions to give seminars/short-lecture series at TEQIP institutions.

(m) Fund specialist national conferences/schools/workshops under TEQIP umbrella.

(n) Give freedom to faculty to do their work – academic autonomy.

(o) Associate faculty from IITs through visiting distinguished faculty positions/chairs/adjunct faculty positions, at the institutions under the TEQIP umbrella.

The outcomes of the detailed discussions are listed in the next section. The summary broadly outlines concrete directions in which effort should be put in order to bring an improvement in quality of academics.

DETAILED REPORT ON CONCLAVE

Day-1: 22nd December 2012

Teaching of Physics and Mechanics: Prof. M. Harbola

- Mechanics brings scientific temper and encourages critical thinking and scientific thought
- *Mechanics fundamental to scientific progress*
- *Connect to everyday examples – implicitly brings in observation, modelling and is relevant. Desist from using example problems which are "foreign" to the student*.
- Why do students find mechanics tough? *Stress on fundamentals, emphasize use of free-body diagrams, create interesting and relevant problems, create good study material.*
- Create simple (inexpensive) demonstrative experiments for use in class-room.
- Encourage discussion, even if inconclusive.
- Concept based approach, and not a simple problem solving exercise (for examinations).
- *Vector approach is a must*, and all colleges should adopt this approach (unfortunately, many colleges prefer staying with the scalar approach).

Teaching of Mathematics: Prof. AK Lal

Prof. Lal gave a presentation on this topic with special emphasis on the following points:

- Essential core course content: ODE, PDE, linear algebra, complex analysis, probability and statistics
- Think logically and analytically

Teaching of vector spaces and matrices was taken as an example to highlight the observed weaknesses in the approach to teaching mathematics. The following points were emphasized:

- *Generalization of ideas- connections between different concepts*
- Class 12 ideas should be connected and corrected. The students remember the formulae but are not able to connect the ideas of same or similar concept. *Students think that each concept is independent.*
- Make students to think
- Develop scientific temper
- *Need to present a refined and abstract look at fundamental concepts* as limits, differentiability, raising curiosity about the next level of mathematics.

- *Need to bring in logical thinking, sound mathematical reasoning and hence emphasis on proofs of fundamental results*.
- Reimann integration, vector spaces, concepts of linear dependence and independence, properties of matrix systems, etc should be taught with certain amount of rigor – move away from formula based rote learning, which does not require stress on concepts.

Discussion points emerged after this talk:

1. Students are addicted to formulae
2. *Seriousness for fundamental science courses is not there, amongst students*.
3. *Connection between mathematics and engineering science* through liaison (faculty from engineering science as an interface as tutors for the tutorial sessions) could work better towards the above problem.
4. Some participants felt that emphasis should be given on applied mathematics rather than routine mathematics teaching.
5. Thought process of the students should be tuned.
6. How to build interest of students in mathematics?
7. Maths, engineering sciences should be taught parallel – continuously, harmoniously reinforce the connection between mathematics, physics and engineering curriculum.
8. Evaluation strategy should be changed with stress not on formula-based problem solving, but on testing understanding of concepts and procedures (*recommendation to universities and institutions*).

Role of materials: Prof. I Manna

Title: **Importance of materials science and microstructure in materials science curriculum**.

Following were the key points in his presentation.

- Initiate the problem and then follow with discussion on how to solve the problem, i.e. issues of material selection for specific application. E.g. High specific Strength, hardness, creep, stiffness, damping properties.
- *Question – how does one design materials to achieve these goals?*
- Microstructure – application to hardware
- Mechanical behaviour and properties
- Tailoring the properties through microstructure
- Material processing
- Classification of materials

Discussion points emerged after this talk:

1. Where this course fits well in curriculum? Which Yr/semester? To this question the participants felt that the 3rd semester when you have done basic physics and chemistry courses.

2. At present the teaching of this course is on higher side of technical content when the students have done the pre-requisite courses much earlier and they find it difficult in revisiting or going back to the concepts form pre-requisite courses. Hence, they find it difficult to connect the concepts. There should be enough provision for revisiting of the pre-requisite courses.
3. *Material science is a must for all mechanical science curriculum – as materials will shape our future* (design new materials for applications).
4. Laboratory components are a must for such course(s).
5. *The students must be allowed and encouraged to pull different types and materials, that is, testing/characterization of materials.*
6. Emphasize hands-on experimentation to prove concepts.
7. Augmenting class-room teaching – recorded lectures by specialists, videos of experiments and their outcomes.
8. Specialized lectures as add on paradigm.

Introductory core program: Profs. Manoj Harbola and Goutam Deo

Typical template presented and contrasted with that of IIT Kanpur. Observation about first three semesters of curriculum:

1. *Compactly packed courses– too much breadth at the cost of depth (no room for query).*
2. Excellent content, but do they meet the learning objectives?

Questions:
What should the student know at the end of three semesters of core learning?
How important is student feedback?

Discussion:

- *Science content of 11th and 12th grades should also be looked at – content should act as an effective precursor of science and technical education*.
- Basic science is very important – IIT Kanpur has even introduced Life Sciences as a mandatory core course to emphasize its importance as a technology driver.
- Approaching problem in various areas will not be difficult with good science background.
- Other components like HSS, Technical Art should also be present.
- Feedback from the students is to be considered
- Content of 11th and 12th calculus as it is repeated in 1st and 2nd year – remove repetition.
- *Define the desired pre-requisite in a program and then decide on mandatory content of science courses*.

Mathematics: - Desired learning by end of 3rd semester:

- differential and integral calculus,
- mathematical modelling of physical phenomenon and systems,
- transform methods,
- vectors and tensors,

- ODE and PDE,
- Numerical tech/analysis
- Complex analysis
- Linear algebra
- Probability and statistics

Rigor of the courses

- Books – need to use good standard books.
- Teaching of mathematics – need to strengthen this part.
- *Develop a minimum common curriculum across all institutes, for all engineering students – Standardized quality issue.*
- To be taught by mathematics faculty – with desired specializations.
- Too much stress on modelling will lead to dilution of rigor and hence will not achieve a major objective – of developing scientific temper.
- *General consensus on explaining of concepts, with sufficient examples*.
- Later in department more emphasis to be given to modelling, which is department specific.
- Web based courses usage /NPTEL – add-on web lectures for on application for additional learning for students.
- Attendance in class (80%) a concern. Take measures to increase attendance and make teaching interesting
- Class strength is high – difficult to pay attention to individual student
- *Passing requirement is simple (examinations are simple) – lack of pressure to pay attention and be regular. Examinations have to become more relevant.*
- Student to faculty ratio too high – skewness in this number has to be removed through good recruitment policies and incentives to faculty. Ideally a lecture should have 40 students, and a tutorial class should have 15-20 students.
- *Learning out-come should be reviewed – rigor versus broad exposure*.

How to address these problems?

- Input from MHRD: IITs to produce more quality PhDs to take up academics as career. These PhDs should find teaching in NITs, State Colleges and other institutions attractive.
- Need to continuously review and reform – to find lasting solutions to fundamental issues rather than superficial quick-fix solutions.
- *Incentives to teachers taking extra load, research grants, for TEQIP institutes academic excellence awards*.
- Ideal faculty to student ratio should be less than 20 for tutorials class.
- Pressure from students to make a course simpler (not to use vectorial and tensorial approach) – instructor should not be afraid to fail non-performing students (backing from institutes?).
- *Promote academic freedom to instructors – especially in private institutions*.
- State colleges need to more proactively recruit quality faculty – system plagued by a centralized recruitment system and delays in recruitment.

Importance of Humanities and Social Science: Prof. A Raina

- Humanities at IIT Kanpur – economics, English, linguistics, psychology, sociology, philosophy, technical arts – give students a broad perspective of this area and encourage interest based further learning.
- Need to emphasize importance of religion (in an increasingly intolerant world), literature, culture, etc.
- Skill based engagements – communicate effectively.

(1) **Sensitizing goal**: Acts as intervention – helps scientists and engineers understand social and economic implications of their role in society. Create aware and responsible citizens

(2) **Bridging goal** – Acts as a bridge between the two cultures – engineering and social science by addressing the following problems:

- Challenge to make good human being
- Competition – not interested in HSS
- HSS becomes integral part for successful engineers.
- Optimal solution in human sense and not engineering sense.
- Teaching of humanities is important and hence its role should be re-emphasized.
- Humanities is not only about communication skills but also about social, economic and philosophical maturity of individuals – leading to better personality and hence better employability.
- *Technical institutes should treat humanities as an integral part of the training of students, and hence effort to should be made to have quality instruction in these topics*. Create engineers who can also solve societal problems.

Discussion on engineering Science and Science Options for Mech. Sciences: Profs. S Mahesh and Sovan Das

- SMD, Fluid Mechanics and Thermal – broad areas of core training in mechanical sciences.
- Common minimum to AE, ME, CE departments.
  (1) Dynamics and statics
  (2) Fluid mechanics and thermodynamics
- Good course content – statics is well taught.
- *Dynamics should be stand alone course* – teaching is weak and scalar oriented. Vector approach has to be strengthened.
- Standard text books should be adopted – develop our own effective text and video/web resources.
- Create repository of content – problem sets, expert lectures on specific topics, class projects, demonstration experiments and hands-on experience (design of simple experiments).
- *Students do not have grasp over fundamentals – formula and problem-solving based teaching, not much stress on concepts; teacher's quality has to be improved.*

Further Discussion: -

1. Course content is good
2. Student evaluation – continuous evaluation desired (quiz, projects, assignments)
3. Standard set and text to be adopted – effort to create our own material.
4. Course content is fine, quality of teaching to be improved
5. Paper setting – level of difficulty to be increased

6. *Descriptive type questions are more – do not effectively test grasp of concepts*.
7. Optional question: The students have to attempt 4 to 5 questions out of 8 – not a good model, as student can skip certain portions of the content (incomplete learning).
8. *Sessional activities do not judge anything – abolish them if possible and introduce class-projects*.
9. Give more control to the teacher.

- In Fluid Mechanics – tensorial approach is missing; first principles are not well understood.
- NPTEL Lectures can be effectively used by the teachers and students as well.
- *Create TEQIP repository of lectures, laboratory manuals, projects, question bank.*
- *Give formula sheet for UG examination with increased level of examination difficulty*.
- Fluid mechanics- teaching of conservation laws in integral form – not all teachers and institute following this form of teaching.

Thermodynamics

- Several text books, vast content, not popular among students
- Practical inputs in teaching
- *Mundane way of teaching, emphasis on fundamentals and connection to different fields of mechanical science missing*.
- Effective visual and demonstration aids should be used.

SMD area

- Dynamics content to be strengthened and able faculty needed to handle this course – this is one area that needs immediate attention.
- Tensor algebra is missing in elasticity/ strength of materials/fluid mechanics.
- *Pedagogy affected due to skewed recruitment – fewer people to teach fluid mechanics and solid mechanics as compared to thermal sciences and design*.

Web – based learning – Brihaspati Platform: Prof. YN Singh

- Need to use web-resources effectively.
- Brihaspati is open-source tool for effective course-management.
- Can be used for live web-cast of courses.
- Several attractive features of access control, translation, tracking of attendance, etc.

Experiments:

Important issues –

1. Maintainance of equipments
2. Availability of manpower
3. **Collaborative use of facilities –** *effective use of resources, quantum jump in quality of research and learning***.**

-*Doing experiment is essential.*
-Fear of experiment must go away.
-Presentation of experiments – honest reporting of data must be emphasized.
-Contingency expenditures must be provided for proper conduct of laboratory courses.

-Make experiments as simple as possible and as cheap as possible. This will take away fear of breaking equipments.
-Involve students to set up experiments.
-Make the students do experiments and minimize demonstrative experiments.
-Process of buying material – tedius in most colleges.
-Rate contract for important materials (MHRD can facilitate this)
-Lot of work involved. IITs should play a role in designing experiments.
-IITs can help in training faculty, technical man-power and students in the use of experimental facilities.
-TEQIP can facilitate sending of technical man-power and faculty for training in use of experimental equipment – better use of equipment, purchase of meaningful experimental equipments in-tune with the desired learning objectives for the courses.
-Wishlist of standard set of experiments must go through rate contract obtained centrally through NPIU– **consensus that this is a brilliant idea!**
-TEQIP should support maintenance of equipment also (AMC).

Technical Manpower:

-Lack of availability of good supporting technical man-power.
-Training of faculty and staff required.
-Career progression path (for retention).

Enhancement of Teaching resources.

Date- 23.12.12

1. *Write good quality textbooks – To be sold in South East Asia (if not the world).*
2. Uniformity in the UG curriculum
3. Mobility of faculty members – faculty members visit other institutions (preferably IITs, IISc) for a short-leave and get involved in courses as instructors, tutor or student – take knowledge back to parent institute.
4. Experienced teachers can teach the important courses.
5. *Prepare a teaching guide. Use animations to enhance learning – TEQIP can coordinate, and IITs can help*.
6. *No differential teaching loads for professor, Associate Professor, assistant professor, etc*.
7. Adopt hierarchy –less structure (MHRD should communicate with AICTE on this)

Desired Credit / Load to students

Science-

3 Mathematics courses,
2 Physics theory + 1 laboratory course
1 Chemistry theory + 1 laboratory course

Engineering Science –

Strength of material
Engineering Mechanics (both Statics and Dynamic must be there)
Fluid Mechanics
Thermodynamics

Strength of Material.
HSS – 10% ~ 4 courses

These courses should be common to all Mechanical Sciences students. Tutorial should be mandatory in the engineering science courses.

One dept teaches, other department faculty members do tutoring.
Teaching load rotates between concerned departments.

Technical Arts courses:

Engineering Graphics should be taught – with aid of modern software.
Workshop Practices – workshop superintendent should be a facilitator + instructor.
Faculty should be in charge of the workshop.

Mandatory Physical Education, communication skills course should be there.

Operation Research and optimization should be also taught at UG level for Mechanical Sciences (use NPTEL resources in the absence of options).

Department Core –

10-11 courses- *a thorough discussion on the courses to be included in this set is required with a more focussed group of faculty in individual disciplines*.

Department Electives-

4 courses (create a basket of courses) – *a more thorough discussion on this issue is required with a more focussed group of faculty from individual discipline/department*.

Multidisciplinary Courses-

Open electives – from different departments. Options should be increased and should be more varied, hence need more faculty.

Library resources
– not uniform.
– sharing of library resources across institutes through e-portals for recommended journals + textbook.
-Wireless internet access to all faculty and students– not uniformly available currently.

- Environmental engineering is compulsory at most of the institutes as per AICTE norms.

Teaching of Dynamics and Vibrations- Prof. Anindya Chatterjee

Discussion:

- *Not many colleges interested in teaching dynamics and vibrations – subject not taught properly*.
- *Faculty from TEQIP institutes will come to IITK for a semester and learn a course and appear for examination and gets a passing grade. Goes back to parent institute and teaches the course.*
- Vectorial and tensorial approach has to be followed.
- *Access to Mathematica/Maple/MatLab for symbolic calculations* involved in dynamics formulations/derivations. This significantly enhances learning.

- *Books/notes with good and short descriptions to developed to aid teaching of the course (for teachers) and the students*.

Teaching Fluid Mechanics: Prof. V Shankar

- First course – again the fundamentals are not taught well
- Differential equation approach, vectorial approach missing.
- Formula based and problem-solving based.
- Need to strengthen fundamental concepts.

Discussion:

- Uniform minimum standard content should be devised.
- Outcome from the course to be defined.

M.Tech. Program detail: Prof. CS Upadhyay

Following items were discussed:

- M. Tech. Program details
- Degree types
- Mandatory courses
- Communication skills for PG students
- Mechanical engineering-specialization on offer
- Civil engineering: Not much available except BESU

Discussion:

- *Add Thermodynamics – to core ME courses*.
- AMU – introduced Modeling and Simulation and basic Numerical Analysis (for all MTech students)
- *Assignments are not thorough – need to create standardized assignments*.

Structural change –

- Department faculty member should teach M.Tech. mathematics courses.
- Shortage of faculty members
- Do not take all courses into account for calculation of CPI.
- Recommend core subject and electives at Master's level.
- Biases (hence skewness of specializations on offer) due to influential faculty members in designing Masters program.
- **Mathematics must be a core compulsory course for MTech.**
- Mathematics content:
  Differential equations + introduction to PDEs; Linear algebra; Complex analysis; Numerical methods; Vectors & tensors.

Engineering faculty should be teaching PG mathematics courses.

Design a basket of core courses *(desired for atleast TEQIP institutions)*
Numerical Analysis and Experimental Methods should be there.

For experiments – Idea is to convey the procedure, objective, hands on, very litle theory (only need to know data acquisition, data analysis)
Project component should be there.
Specialization of M.Tech programs – leave the choice to the individual department.
MS by research and M.Tech thesis options can be looked at apart from existing M.Tech by project work.
Leave the options to the department / institute on the mode of thesis / project / industry internship.

No effective measures of checking Plagiarism is in place.
Create TEQIP repository, put everything on the web (including thesis and reports).
Degree should be revoked, if plagiarism is proven.
"Turn-it-in"- Plagiarism Software.
People are not aware of Plagiarism.
Review process should be better.
Create repository for interesting and societal (relevant) problems.

Thesis /Project:

- Most of the institutes have M Tech program as course intensive (upto 13 courses) and short project – evolve benchmark for quality of projects.
- Possibility of MS by research and M.Tech. thesis to be looked at (fewer courses, rigorous thesis/project).

Quality of Thesis/Project:

- Pre- Evaluation of thesis
- Suggestions to be given to improve the quality
- No check on plagiarism
- Industrial experience component to be added may be to gather data before starting thesis.
- Thesis should bring originality in the work.
- ***Evaluation-by third person***

PhD Programme: Prof. Anindya Chatterjee

- TEQIP funds for INDEST – journal access
- Different funds to institutes.
- TEQIP post-doc fellowship – for TEQIP institution faculty to do post-doctoral work at an IIT/IISc.
- Can come to IITs/IISC under "study leave" – TEQIP sponsors leave, travel, stay.
- Seminars and workshops organized by IITs/IISc can be attend by TEQIP faculty (by granting leave, TA/DA).
- Publication before PhD thesis submission not compulsory as review may take long time. However, these publications help to get thesis reviewed before it is sent for review.
- Attending conferences in India/abroad should be encouraged.

- National conferences, annual workshops funded by TEQIP in Mechanics and other specializations.
- Visiting professorship funded by TEQIP – e.g. for sabbatical leave.

Quality of PhD thesis:

- *Joint guidance – rules governed by parent institute to be followed.*
- Course requirement component to be made mandatory.
- Minimum required courses must be done as training is required in PhD
- ***5-6 courses must be made compulsory***.

Infrastructure Support: Prof. C S Upadhyay

- Centralised rate contract based procurement – remove local impediments to purchase, streamline purchase procedures, reduce hassle in purchase.
- Effective utilization of equipment is not happening.
- Maintenance and equipment development projects to be given to students.
- Grants for attending conferences in India and abroad.
- Repository of question papers as a guide and question bank (with answers to TEQIP instructors).
- Course files on specific courses, as a repository, to be used by future instructors as a guide and also to evaluate the effectiveness of the content delivery.
- Paper setting by IIT faculties.

Hiring of faculty members:

PhD specialization should be looked into. Just having a PhD is not enough. This is necessary to maintain diversity.
MHRD should recommend TEQIP institutes have autonomy in hiring and have rolling advertisement to continuously hire.
Recommend that faculty needed (with PhDs) for each specialized PG program (Do not provide quota) – list desired specialization.
Have an internal mechanism to recommend number of specialists needed.
Request spreadsheet from departments with people listed by specialization.
Eligibility criteria should be relaxed – especially for state colleges (NET qualification should not be mandatory).

Hiring procedure of IIT's should be recommended for TEQIP institutes. (MHRD should enact this through NIT council/ AICTE/UGC).

Hiring is recommended for PhD's with provisional certificate.
To get hired, current norm is that BTech, MTech, PhDs of the candidate must be in same branch – **This should change**. Allow flexibility (one degree in same branch).

APPENDIX – I (Schedule)
TEQIP conclave of Educators
On quality of delivered academics in Mechanical Sciences

Session	**Day 1** (22 December)	**Day 2** (23 December)
9:00 – 10:00	**Inauguration**	Summary of Day 1: Action points
10:00–10:15	Teaching of physics and mechanics (Prof. M. Harbola)	Teaching of dynamics and vibrations – Prof. A. Chatterjee
10:15- 10:30	Discussion on physics for Mech. Sc.	Discussion on dynamics for Mech. Sc
10:30–10:45	**Tea**	**Tea**
10:45-11:00	Teaching of mathematics (Prof. A. Lal)	Teaching of fluid-mechanics (Prof. V. Shankar)
11:00- 11:15	Discussion on mathematics for Mech. Sc.	Discussion on fluid mech. for Mech. Sc.
11:15-11:30	Role of material science (Prof. I. Manna)	*Summary of Graduate programs at TEQIP institutions*
11:30-12:00	Introductory core program – *Overview of a typical template*; Role and rigor of introductory core program; Availability of faculty and lab. Infra-structure; Pitfalls and improvements.	Masters Program: Program structure (course or research intensive); higher mathematics I&II; intro. to computation; TEQIP expert lectures as part of electives (web-resources?); masters' thesis or project; TEQIP studentship to excellent students (1 semester at IIT); TEQIP fellowship for PhD at IITs .
12:00-12:15	*Engineering Science options – a presentation*	TEQIP Teachers training in speciality courses
12:15-12:45	Discussion on Engineering Science and Science Options for Mechanical Sciences – Essential courses; Infra-structure and human resources for effective teaching. Survey of departmental professional courses	PhD Program: Number and type of courses; improvement of doctoral research quality through collaborative research (joint guidance), exchange research credits (TEQIP studentship for doing courses at IITs), sharing of resources; review and examination process, post doctoral training (TEQIP postdoctoral fellowships).
12:45 -13:15	Hands-on training: Training in measurement and instrumentation; Laboratory objectives and requirements for effective student participation; training of laboratory instructors.	Research support at TEQIP institutions: Infrastructure for research; library facilities and journals (TEQIP repository); expert visits (TEQIP distinguished faculty); TEQIP centres of research; TEQIP scholars conference; adjunct faculty, TEQIP seminar series.
13:15-13:30	Importance of Social Sciences (Prof. A. Raina)	TEQIP thematic workshops
13:30-15:00	**LUNCH**	**LUNCH**
15:00–15:30	Enhancement of teaching resources and quality for TEQIP institutions - unified curriculum; standardized texts and web-resources; Repository of course files and question bank.	Discussion on faculty advancement: Support for conferences, workshops, research fellowships (TEQIP visiting faculty) at IITs/IISc (long and short term), joint projects, encourage PhD from premier institutions (TEQIP faculty fellowship); support for post-doctoral position at IITs and IISc (TEQIP postdoctoral fellows).
15:30-15:45	**Coffee Talk**: Web-based learning-Brihaspati platform (Prof. YN Singh)	**Coffee Talk**: Role of continuum mechanics and constitutive modelling (Prof. I.Sharma)
15:45-16:15	NPTEL resources: Use and augmentation	*Conclusion – action points*
16:15-16:45	Should UG project be compulsory?	Visit to Mechanical Aerospace/Chemical/Civil/Material Engineering Labs.
16:45-17:30	Recommmendations for supporting infra-structure in TEQIP institutions: Library, laboratories, computational facilities, wireless access, technical manpower, teaching load.	
19:00-	Dinner	Dinner

APPENDIX – II

DISTRIBUTION OF VARIOUS COMPONENTS OF UG PROGRAM

PERCENTAGE CREDIT ALLOCATION AT IIT KANPUR

• BROAD-BASED EDUCATION

Item	Broad Area	Proposed Percentage of total credits	AMU
1	HSS (excluding Management, Comm Skills etc.)	10%	7.2%
2	Science (including electives)	20%	15.4%
3	Engineering Science (E Sc, ESO)	10%	19.3%
4	Technical Arts	5%	-
5	Management + PE + Comm Skills + Foreign Language	5%	-
6	Department Core (Mandatory)	25%	46.8%
7	Department Elective	10%	7.3%
8	Open Elective (Room for Minor)	15%	3.6%

UG TEMPLATE AT IIT KANPUR

Table 2. Example template for a four-year programme

Sem	Course			Sem	Course		
I	MTH101 (Calculus) CHM102 PHY101/CHM101 (Lab) [TA101 (Engg. Graphics)+ LIF101 (Life Sciences)]/ ESC101 (Computing) ENG112/HSS-1 * PE101 *TA101 & LIF101 alternate with ESC101*	3-1-0 2-1-0 0-0-3 [2-0-2+ 2-0-0]/ 3-1-3 3-1-0 0-0-3	11 08 03 [08 + 06]/ 14 11 03 **50**	II	MTH102 (Lin Al, ODE,...) PHY102 (Mechanics) CHM101/PHY101 (Lab) [TA101 (Engg. Graphics)+ LIF101 (Life Sciences)]/ ESC101 (Computing) HSS-2 (Level 1) * PE102 *TA101 & LIF101 alternate with ESC101*	3-1-0 3-1-0 0-0-3 [2-0-2 + 2-0-0]/ 3-1-3 3-1-3 0-0-3	11 11 03 [08 + 06]/ 14 14 03 **56**
III	PHY201 [ESC102 (Electronics)/ ESO-1/SO-1] ESO-2/SO-2 DEPT TA201 (MME)/TA102(Mech) ** Composition (Web based)	3-1-0 [3-1-3/ 3-1-0] 3-1-0 3-0-0 1-0-3 0-0-2	11 [14/ 11] 11 09 06 02 **53/ 50**	IV	SO-3 [ESC102 (Electronics)/ ESO-1/SO-1] HSS-3 (Level 2)/ DEPT DEPT OE-1 / DEPT TA102 (Mech)/TA201 (MME)	3-1-0 [3-1-3/ 3-1-0] 3-0-0 3-0-0 3-0-0 1-0-3	11 [14/ 11] 09 09 09 06 **55/ 58**
V	ESO-3 DEPT DEPT HSS-4 (Level 2) / DEPT UGP1 (Optional) OE-2 / DEPT ** Comm Skills (Deptt)	3-1-0 3-0-0 3-0-0 3-0-0 0-0-4 3-0-0 0-0-2	11 09 09 09 04 09 02 **49/ 53**	VI	DEPT / OE-1 DEPT / HSS-3 (Level 2) DEPT DEPT [UGP2/ OE/DE] OE-3 / DEPT	3-0-0 3-0-0 3-0-0 3-0-0 [0-0-9/ 3-0-0] 3-0-0	09 09 09 09 [09/ 09] 09 **54**
VII	OE-4 / DE-1 DEPT / HSS-4 (Level 2) DEPT / OE-2 HSS-5 (Level 2) / DE-2 [UGP3/ OE/DE]	3-0-0 3-0-0 3-0-0 3-0-0 [0-0-9/ 3-0-0]	09 09 09 09 [09/ 09] **45**	VIII	DEPT / OE-3 DE-1 / OE-4 DE-2 / HSS-5 (Level 2) OE-5 OE-6 UGP4 (Extra credits)	3-0-0 3-0-0 3-0-0 3-0-0 3-0-0 0-0-9	09 09 09 09 09 09 **45/ 54**

APPENDIX - III

GOALS OF AN ACADEMIC PROGRAM (*See also ABET norms for 2013-2014*)

- **STUDENT: Evaluate student for success in attaining learning objectives**
- **PROGRAM OBJECTIVES: Stated program objectives with regular review**
- **STUDENT OUTCOMES:**
  - **Ability to apply knowledge of mathematics, science and engineering;**
  - **Conduct experiments and analyze data;**
  - **Design a component, system or process to meet desired needs within given feasibility constraints;**
  - **Function on teams;**
  - **Ability to identify, model and solve engineering problems;**
  - **Communicate effectively;**
  - **Have good social skills and professional ethics;**
  - **Be a responsible citizen**

DESIRED STRUCTURE OF UNDERGRADUATE PROGRAM

- **1 year of college mathematics and basic sciences relevant to program**
- **1.5 years of engineering sciences and engineering design – roots in basic mathematics and science but carry knowledge further to creative applications.**

  - Bridge between mathematics, science and engineering practice.
- **General education component complementing technical content and consistent with program and institute objectives.**
- **Culmination of engineering training with a major design exercise, using the tools and knowledge gained.**

FACULTY –

- **Should have competency to cover all major areas of program;**

- **Numbers should be sufficient to have good student-faculty interaction;**
- **Should have sufficient qualification to demonstrate authority over subject being taught;**
- **Have vision to implement effective processes and improve program and learning outcomes;**
- **Should have diverse background, experience and training.**

DESIRED STRUCTURE OF UNDERGRADUATE PROGRAM

- **FACILITIES:**

❑ **Classrooms, offices, labs and associated equipments must be adequate to support the attainment of student outcomes and to provide the atmosphere conducive for learning**

❑ **Modern tools, equipments, computing resources and labs must be available, accessible, systematically maintained and upgraded**

❑ **Students must be provided appropriate guidance regarding the use of tools, equipment, computing resources and labs available for the program**

❑ **Library and the computing and information infrastructure must be adequate to support the scholarly and professional activities of the students and faculty.**

- **INSTITUTIONAL SUPPORT:**

❑ **To ensure the quality and continuity of the program**

❑ **Resources, financial support and staff must be provided**

❑ **Resources must be sufficient to acquire, maintain and operate infrastructure, facilities and equipment appropriate for the program.**

DESIRED STRUCTURE OF POSTGRADUATE PROGRAM

- **OBJECTIVE: Program must develop, publish and periodically review educational objectives and student outcomes**
- **CRITERIA:**

o **Fulfillment of the baccalaureate level general criteria;**

o **Fulfillment of program criteria appropriate to the masters level specialization area;**

- **1 academic year of study beyond the baccalaureate level**

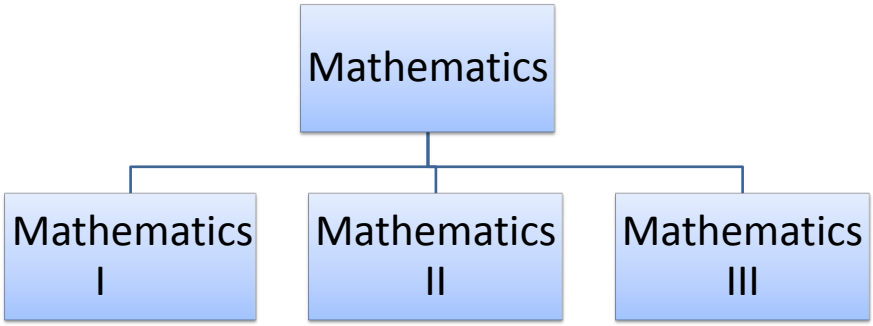
- **OUTCOME: Graduates have an ability to apply masters level knowledge in a specialized area of engineering related to the program area**

Masters in Mechanical Sciences:

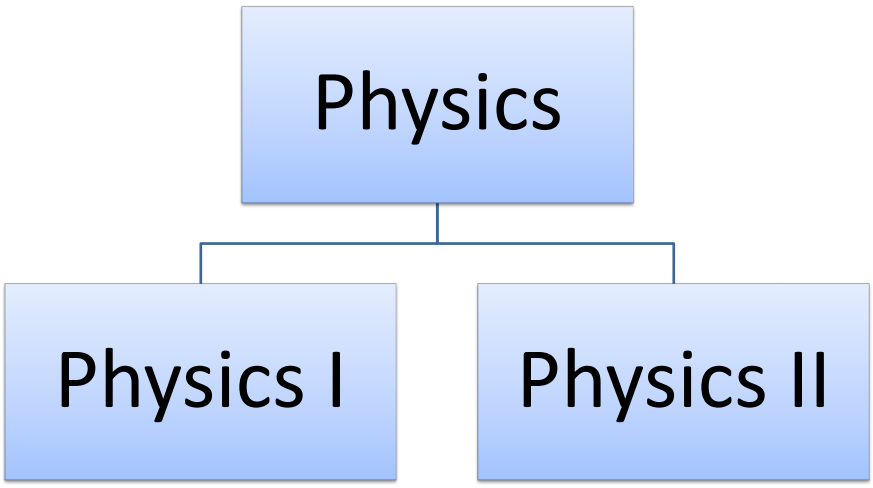
Apply knowledge of differential equations, mathematics and calculus based physics and chemistry; apply knowledge of several sub-areas of mechanical sciences; conduct experiments, analyze and interpret data to design components or process or systems.

APPENDIX – IV

CONTENT OF MATHEMATICS AND PHYSICS TAUGHT AT TEQIP INSTITUTIONS



These three courses (mathematics-I,II &II) are covered in 1st , 2nd and 3rd semester respectively.
Note- Some colleges also take fourth mathematics course in fourth semester



Physics I & II are covered in semester 1 and 2 respectively
Note - Some college take single physics course

Mathematics-I

- **Most Common topics covered are**

- Functions of One Real Variable.
- Functions of Several Real Variables.
- Vector Calculus.
- Applications of Differentiation.
- Multiple Integrals and their Applications.
- Partial Differentiation & its Applications.
- Infinite series
- Complex Numbers
- Optimization

- Vector Calculus is part of mathematics II in NC college of engg. & NIT Raipur.
- Infinite series is part of mathematics II in GB pant and mathematics III in Jadavpur university & Guru Jambeshwar university.

Most Common Books

- Advanced Engineering Mathematics : F. Kreyszig.
- Higher Engineering Mathematics : B.S. Grewal.
- Engineering Mathematics Part-I : S.S. Sastry.
- Differential and Integral Calculus : Piskunov.
- Advanced Engineering Mathematics : R.K. Jain and S.R.K.Iyengar
- Advanced Engg. Mathematics : Michael D. Greenberg

Mathematics-II

- **Most Common topics covered are**

- Series Solutions and Special Functions
- Matrices and Linear Algebra
- Ordinary Differential Equations & its Applications
- Partial Differential Equations
- Modeling and Boundary-Value Problems
- Laplace transforms and its applications
- Fourier series and Fourier transforms

- Laplace transforms and its applications is part of mathematics III **in Faculty of Engineering and Technology, Jadavpur university Kolkata.**
- Fourier series and Fourier transforms is part of mathematics III in **Guru Jambeshwar university of SC & Tech Hissar and UIET, Kurukshetra University.**

Most Common Books

- **R. K. Jain & S. R. K. Iyengar; Advanced Engineering Mathematics, Narosa Publishing House, 2002.**
- **Erwin Kreyszig; Advanced Engineering Mathematics, John Wiley & Sons 8th Edition.**
- **Advanced Engg. Mathematics F Kreyszig**
- **Higher Engg. Mathematics B.S. Grewal**
- Dennis G, Zill & Michael R. Cullen; Advanced Engineering Mathematics, Jones & Bartlett Publishers. 2nd Edition.
- Differential Equations – H.T.H. Piaggio.
- Elements of Partial Differential Equations – I.N. Sneddon.
- Advanced Engg. Mathematics – Michael D. Greenberg.
- Ramana, B.V., “Higher Engineering Mathematics” Tata McGraw-Hill.

Physics II

- **Most Common topics covered are**

- Modern Physics
- Quantum Mechanics
- Band Theory Of Solids
- Free Electron Theory
- Super Conductivity
- Photoconductivity and Photovoltaics:
- Crystal Structure:

- No University Covers Mechanics part in any physics Course.

Most Common Books

- Introduction to Solid State Physics (VII Ed.) – Charles Kittel (John Wiley).
- Quantum Mechanics – Powell and Crasemann (Oxford & IBH)
- Fundamentals of Solid State Physics – B.S.Saxena, R.C.Gupta and P.N.Saxena (Pragati Prakashan).

- Faculty of engineering and technology jadavpur university kolkata and Gobind Ballabh Pant Engineering College, Pauri Garhwal do not offer physics II course

PHYSICS I AT IIT KANPUR - MECHANICS

• BEYOND 12TH GRADE PHYSICS

• STRENGTHEN SCIENTIFIC FOUNDATION

• INCULCATE SCIENTIFIC TEMPERAMENT AND THOUGHT PROCESS

•DEMONSTRATIVE EXPERIMENTS

•TEXT: *AN INTRODUCTION TO MECHANICS – KLEPPNER AND KOLENKOW*

S. No.	Topic	Suggested number of lectures
1	Transformation of Scalars and Vectors under Rotation Transformation, Form Invariance of Newton's Second Law, Forces in Nature	2
2	Solving Newton's Equations of Motion in Polar Coordinates for problems including Constraint and Friction, extension to Cylindrical and Spherical Coordinates	6
3	Potential Energy Function, F=-Grad V, Conservative and Non-Conservative Forces	3
4	Central Forces, Conservation of Angular Momentum, Centrifugal Term and Effective Potential Energy, Energy Equation and Energy Diagrams, Elliptical, Parabolic, and Hyperbolic Orbits, Satellite Maneuvers	3
5	Harmonic Oscillator, Damped Harmonic Motion, Forced Oscillations and Resonance, inclusion of Nonlinear Force and Chaotic Motion, Phase-Space Description	5
6	Non-Inertial Frames of Reference, Principle of Equivalence, Centrifugal and Coriolis Forces, Weather Systems, Foucault Pendulum	3
7	Angular Momentum and Torque, Rigid Body Dynamics, Degrees of Freedom, Angular Velocity Vector, Moment of Inertia Tensor, Principal Axes, Torque-Free Precession, Gyroscopes, Euler's Equations	8
8	Special Theory of Relativity, Michelson-Morley Experiment, Postulates, Derivation of Lorentz Transformation, Concept of Simultaneity, Length Contraction, Time Dilation, Velocity Addition, Relativistic Dynamics, Energy-Momentum Conservation in Collisions, Energy-Mass Relation	10
	Total number of lectures	**40**

PHYSICS II AT IIT KANPUR

• ELECTRODYNAMICS –
•BOOK – "ELECTRODYNAMICS" GRIFFITHS

• ADDITIONAL MODULES ON WAVE MECHANICS AND RELATIVITY

•ADDITIONAL PHYSICS LABORATORY COURSE

Approximate lecture-wise break-up (lecture duration : 50 minutes)

Topic	Approximate number of lectures
Vector calculus	6
Electrostatic with full use of vector calculus – calculation of electric fields, electrostatic potential and Laplace's equation and uniqueness of its solution; Method of images; Energy in electrostatics	8
Introduction to multipole expansion, Dipole moment of a charge distribution, potential and field of a dipole, force and torque on a dipole in an electric field; Electrostatics in a medium, Displacement vector and boundary conditions, linear dielectrics, force on a dielectric	7
Magnetostatics with full use of vector calculus, introduction to vector potential	4
Current densities, Lorentz force law, force and torque on a magnetic dipole in a magnetic field Magnetostatics in a medium, Magnetization, bound currents, magnetic field H, Boundary conditions on B and H, magnetic susceptibility, ferro para and diamagnetism	4
Faraday's law, energy in magnetic field; displacement current; fields produced by time-dependent electric and magnetic fields within quasi-static approximation	4
Maxwell's equations in vacuum and conducting and non-conducting medium, energy in an electromagnetic field, Poynting vector, plane electromagnetic waves and polarization; Reflection and refraction of electromagnetic waves from a boundary, Brewster's angle, total internal reflection etc.	8
Total number of lectures	**40**

APPENDIX VI

Engineering Science CORE COURSES

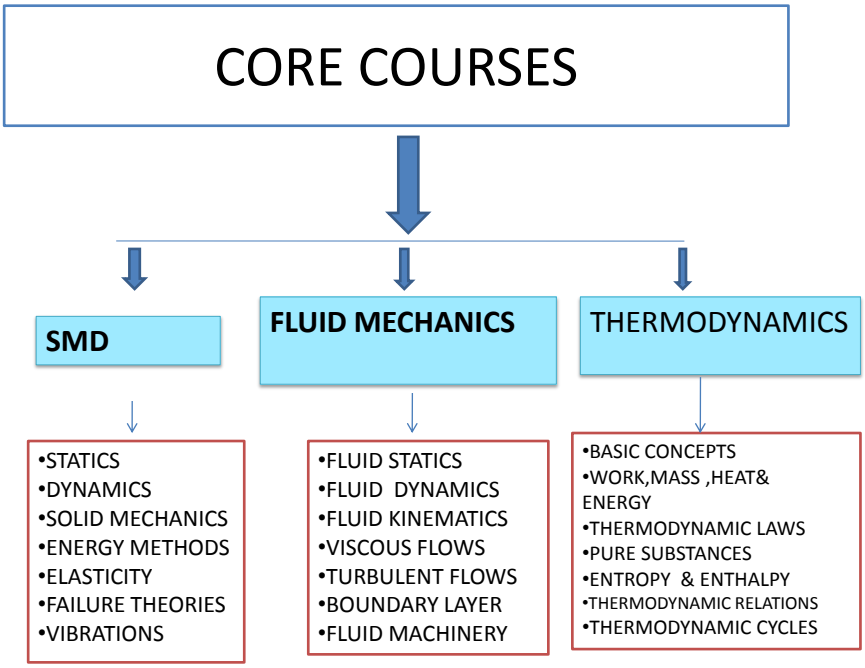
For Mechanical Sciences (Mechanical, Civil, Aerospace, Production)

Dynamics and Solid Mechanics

- Engineering Mechanics: Statics
- Engineering Mechanics: Dynamics
- Strength of Materials
- Vibrations

Fluid and Thermal Sciences:

- Fluid Mechanics
- Thermodynamics



CORE MECHANICS SEMESTER -WISE COURSE DISTRIBUTION

STATICS AND DYNAMICS

SEMESTER 1ST OR 2ND

Most recommended books- Shames,
- Crandall & Dahl
- Beer and Johnson

- UNITS AND DIMENSIONS ,VECTOR ALGEBRA.
- FORCE VECTORS AND FREEBODY DIAGRAMS
- EQUILIBRIUM –STATIC AND DYNAMIC
- STRUCTURAL ANALYSIS-TRUSSES,FRAMES etc
- CENTROID,CENTRE OF MASS,MOMENT OF INERTIA
- PARALLEL AND PERPENDICULAR AXIS THEOREMS

- ROTATION OF RIGID BODIES,ANGULAR MOMENTUM .
- EQUATIONS OF MOTION –TRANSLATION AND ROTATION
- FORCE AND ACCELERATION, WORK AND ENERGY.
- THREE DIMENSIONAL KINEMATICS OF RIGID BODY

ENGINEERING MECHANICS-STATICS AND DYNAMICS

- Course is offered as "**BASIC MECHANICAL ENGINEERING**" in most of the Universities.

- Prerequisite for many courses like Strength of Materials and Dynamics of Machines.

- It is found that **Units and Dimensions ,Vector Algebra, Free Body Diagram** are not included or given importance in many universities in their curriculum.

- Classical books were **not** followed in majority of colleges.

COURSE CONTENTS

ELASTICITY

Offered in 4th Semester as an advanced core course.

- EQUILIBRIUM EQUATIONS
- PLANE STRESS AND PLANE STRAIN
- COMPATIBILITY EQUATIONS
- AIRY STRESS FUNCTION
- SAINT VENANT'S PRINCIPLE
- TORSION
- WARPING –OPEN THIN WALLED SECTIONS ,CLOSED THIN WALLED SECTIONS.
- BI-DIRECTIONAL BENDING
- SHEAR FLOWS
- ELASTIC BUCKLING

COURSE CONTENTS

FLUID MECHANICS

- **FLUID STATICS-** Gas Laws, Surface Tension, Pressure ,Manometers,Streamlines,vorticity and circulation.
- **FLUID DYNAMICS**-Euler's and Bernoulli's equation, Energy equations.
- **FLUID KINEMATICS**- Rotational and Irrotational flows, Steady and unsteady flows, Lagrangian and Eulerian methods,Reynold's Transportation theorem. Source ,sink and vortex. Superposition of flows.
- **VISCOUS FLOWS-** Viscous flows,Navier stokes Equations, Pipe Flow.
- **BOUNDARY LAYER THEORY-** Reynold's Number, Turbulent flows, Boundary layer growth.

Most recommended books authored by 1) Munson,Okiishi
2) K.L.Kumar

Fluid Machinery books authored by 1) Som and Biswas.

COURSE CONTENTS

THERMODYNAMICS

- OPEN AND CLOSED SYSTEMS.
- INTENSIVE AND EXTENSIVE PROPERTIES
- STATE ,PATH,PROCESS AND CYCLE.
- GAS LAWS, ENTHALPY AND ENTROPY.
- WORK AND HEAT TRANSFER.
- LAWS OF THERMODYNAMICS
- REVERSIBLE AND IRREVERSIBLE PROCESS
- THERMODYNAMIC CYCLES-BRAYTON,CARNOT etc
- THERMODYNAMIC RELATIONS-MAXWELL RELATIONS,GIBBS FUNCTION etc
- PURE SUBSTANCE,PHASE TRANSFORMATIONS.

Most recommended books authored by: 1)Roger, GFC & Mayhew
2) Younis Cengel
3)Nag P.K.
4) Rajput R.K.

Engineering Science CORE COURSES

For Mechanical Sciences (Mechanical, Civil, Aerospace, Production)

Dynamics and Solid Mechanics

- Engineering Mechanics: Statics
- Engineering Mechanics: Dynamics
- Strength of Materials
- Vibrations

Fluid and Thermal Sciences:

- Fluid Mechanics
- Thermodynamics

Summary

Course contents look fine! In fact, very good.

Textbooks appear standard.

Yet, majority of students, in our experience, do not have grasp over fundamentals.

For example,

- cannot draw a proper free body diagram
- cannot derive equations for a simple pendulum
- weak in deriving governing differential equations for conservation of mass, momentum and energy for simple systems – beams, one-dimensional flow, heat conduction.

So where is the problem?
What are the solutions?

APPENDIX VII (Experimental courses)

FLUID MECHANICS

Course content: Introduction; Reynolds Transport Theorem; Integral form of continuity, momentum and energy equations; Eulerian and Lagrangian view-points; Constitutive relations; Navier Stokes equations; Exact solutions; Potential flow; Boundary layer theory; Separation and drag; Turbulent flow: Reynolds averaged equations; Turbulent flows in pipes and channels; compressible flows

Laboratory sessions:

Sessions	Name of the experiment
1	Flow visualization around streamlined and bluff objects (including multimedia resources)
2	Measurement of viscosity of liquids and gases
3	Force acting on a circular cylinder placed in cross-flow
4	Probes and transducers – pitot static tube, 5-hole probe, manometers, hotwire anemometer, Wind tunnels (This material is to be covered in a one hour lecture.)
5	Measurement of velocity and velocity fluctuations in a turbulent mixing layer
6	Boundary-layer flow over a flat plate (laminar and turbulent)
Total number of laboratory sessions: 6	

Module II

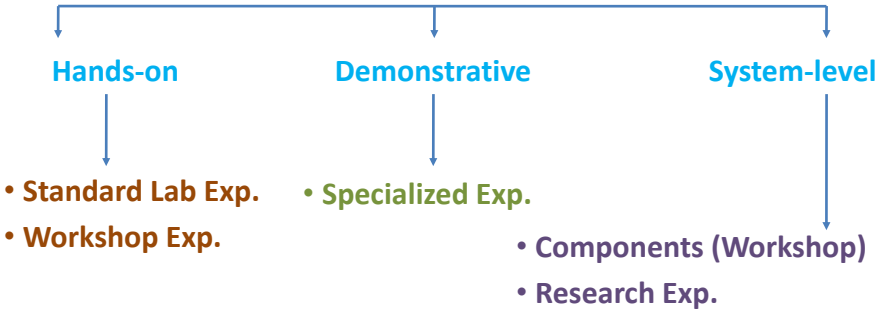
<About 10 experiments + 1 High speed aerodynamics expt.>

- Basic experiments with different sensors
  - Calibration
  - Error analysis
  - Signal conditioning
  - Specific measurements

- Material characterization
- Flow visualization
- 3-4 experiments in each specialization

< Load cell calibration, bending of beams, shear centre, torsion, UTM (static tests); laser light flow visualization, smoke flow visualization, Hilishaw flow visualization, hot wire anemometry (calibration + test), calibration of low-speed tunnel, flow past circular cylinder; calibration and use of pressure sensors (steady & unsteady), thermocouple+ flame temp. measurement; Schiliren + shadowgraphy, measurement of M for pressure, pressure and moment measurement >

Experiments Categorization



- Field experiments (civil)
- Industry (mech. eg. boiler)

Experiments: Issues

- Level of support for lab. Equipment:
  - purchase,
  - maintenance,
  - upgradation ,
  - Space
- Tinkering labs.: Freedom to students
- Standardization of tests:
  - quality and reliability of data

Experiments: Training

- Training of manpower:
  - Faculty
  - Lab staff
  - Workshop staff

- Training for:
  - new equipments,
  - specialized processes

- Ways of Training:
  - In-house
  - Outside the institute
  - Experts visiting the institute

- Support for Training:

Experiments: Summary of the Institutes

- Standard experiments

- Mostly practical/lab sessions are held

- Standard report writing

- A few electives in measurements and instrumentations

APPENDIX VIII (Distribution of academic load for TEQIP institutions)

Item	Civil Engineering	Mechanical Engineering
No. of UG Students	60x4 – 100x4	60x4 – 130x4
Humanities Courses (%)	5 – 8	4 - 10
Science Courses (%)	13 - 16	13 - 35
Departmental Courses (%)	77 – 82	58 - 83
Dept. Core Electives (%)	8.5 – 10.25	3.6 - 8
B. Tech. Project	Yes	Yes
No. of M. Tech. Students	18 – 30	18 - 42
No. of Specializations	3 – 5	3 - 6
No. of Courses	##	11-13
Thesis/Project Duration	1 year	1 year

Item	Civil Engineering	Mechanical Engineering
No. of PhD Students	2 – 56	2 – 13
No. of Specializations	1 – 5	1 – 6*
No. of Courses (Mandatory)	-	2*
No. of Publications (last 5 yrs)	11 – 39	32 - 65
Faculty Strength	16 – 26	8 - 36
Student Faculty Ratio	16 – 19	16 - 32
Faculty with PhD (%)	16 - 73	9 - 70
Faculty with Post-doc Experience	8 - 12	4 - 7

* AMU

Deenbandhu Chhotu Ram University of Sci. Tech. and AMU offers 13 courses for M.Tech. (Mech)

NC College of Engg has 1 post doc faculty out of 25 in Mechanical, AMU has 2 post-doc faculties

BTKIT has no faculty with PhD in Civil

APPENDIX – IX

MECHANICAL AND CIVIL ENGINEERING TEMPLATES AT IIT KANPUR

UG TEMPLATE FOR MECHANICAL ENGINEERING

ESO Courses:

1. ESO202: Thermodynamics 3-1-0-11
2. ESO204: Mechanics of Solids 3-1-0-11
3. ESO210: Introduction to Electrical Engineering 3-1-0-11

SO Courses:

1. MTH203 Mathematics III (PDE+Complex Analysis) 3-1-0-11

Compulsory Dept. Courses:

1. ESO206: Engineering Dynamics 2-1-0-8
2. ME222: Nature and Properties of Materials 2-0-1-7
3. ME231: Fluid Mechanics 3-0-0-10
4. ME251: Engineering Design and Graphics 1-0-2-5
5. ME301: Energy Systems I 3-0-1-10
6. ME321: Advanced Mechanics of Solids 2-0-1-7
7. ME341: Heat and Mass Transfer 3-0-1-10
8. ME351: Design of Machine Elements 2-0-2-8
9. ME352: Theory of Machines and Mechanisms 2-0-1-7
10. ME354: Vibration and Control 3-0-1-10
11. ME361: Manufacturing Technology 3-0-1-10
12. ME401: Energy Systems II 2-0-0-6
13. ME461: Manufacturing Systems 3-0-0-9
14. UGP2: ME451 Project I 0-0-9-9
15. UGP3: ME452 Project II 0-0-6-6

TEMPLATE FOR CIVIL ENGINEERING AT IIT KANPUR

L-T-P-A	Credits	Title	Number
3-0-3-0	12	Environmental Quality and Pollution	CE211
3-0-2-0	11	Civil Engineering Materials	CE242
2-0-2-0	08	Engineering Hydraulics	CE262
3-0-0-0	09	Structural Analysis	CE272
2-0-2-0	08	Engineering Geosciences	CE321
3-0-2-0	11	Geoinformatics	CE331
2-0-2-0	08	Soil Mechanics	CE351
2-0-1-0	07	Foundation Design	CE352
2-0-0-0	06	Engineering Hydrology	CE361
2-0-0-0	06	Design of Steel Structures	CE371
2-0-0-0	06	Design of Reinforced Concrete Structures	CE372
3-0-0-0	09	Introduction to Transportation Engineering	CE382
2-0-0-0	06	Construction Management	CE 441

Electives in Basket A

A minimum 22 credits is required from this basket.

L-T-P-A Credits Title Number

3-0-2-0 11 Water Supply and Wastewater Disposal System CE 412
3-0-0-2 11 Application of Geotechnical Engineering CE 451
3-1-0-0 11 Hydraulic and Hydrologic Design CE 462
3-0-0-2 11 Special Topics in Structural Design CE 471
3-0-0-2 11 Transportation Facilities Design CE 481

3.6 Electives in Basket B

No Minimum credit requirement from this basket. At least two courses in addition to the UG Research I and II will be made available to the students every semester.

L-T-P-A Credits Title Number

3-0-0-0 09 Physical and Environmental Geology CE 422
3-0-0-0 09 Advanced Measurement Techniques CE 431
3-0-0-0 09 Civil Engineering Systems Analysis CE 642A
0-0-0-9 09 UG Research I CE 491
0-0-0-9 09 UG Research II CE 492
Other PG Courses: as available from time to time.

3.7 Optional and Extra Credit Courses

L-T-P-A Credits Title Number

0-0-4-0 04 Survey and Geology Camp (Optional) CE 332
0-0-0-9 09 UG Research III (Extra Credits) CE 493

APPENDIX X (Mandatory courses for B. Tech in mechanical and civil engineering)

Below is a list of 30 Civil Engineering Courses. Please choose TEN most important courses (in your view) and rank them in order of preferences (1=most important, 10=least important)

Sl. No	Course Title	Rank
1	Surveying	
2	Civil Engineering Materials	
3	Environmental Quality and Pollution	
4	Engineering Hydraulics	
5	Soil Mechanics	
6	Theory of Structures	
7	Design of Structures	
8	Foundation Engineering	
9	Transport Engineering	
10	Concrete Technology	
11	Environmental Engineering	
12	Water Resources Engineering	
13	Project Planning and Management	
14	Construction Technology	
15	Geotechnical Investigations and Practices	
16	Rock Engineering	
17	Pavement Engineering	
18	Bridge Engineering	
19	Irrigation Water Management, Drainage & Flood Control	
20	Unit Operation & Process for Water Quality Control	
21	Remote Sensing	
22	Model Analysis for Structures	
23	Earth & Earth Retaining Structures	
24	Traffic Engineering & Management	
25	Hydraulic Structures	
26	Industrial Pollution and Control	
27	Analysis and Design of Offshore Structures	
28	Seismology & Earthquake Engineering	
29	Geoinformatics	
30	River Engineering	
31	Dynamics and Vibrations	

Below is a list of 30 Mechanical Engineering Courses. Please choose TEN most important courses (in your view) and rank them in order of preferences (1=most important, 10=least important)

Sl. No	Course Title	Rank
1	Heat and Mass Transfer	
2	Advanced Mechanics of Solids/Theory of Elasticity	
3	Theory of Machines & Mechanisms	
4	Manufacturing Technology	
5	Energy Systems	
6	Fluid Machines	
7	Control Theory	
8	Automation	
9	Finite Element Analysis	
10	Computational Fluid Dynamics	
11	Industrial Engineering	
12	Design of Machine Elements	
13	Operations Research	
14	Machining Science	
15	Theory of Vibration	
16	Machine Drawing (including AUTOCAD)	
17	Mechanical Measurement & Instrumentation	
18	Robotics	
19	Numerical Methods	
20	Machine Tools and Metal Cutting	
21	Steam and Gas Turbines	
22	Refrigeration and Air Conditioning	
23	Tribology	
24	Computer Aided Design	
25	Nontraditional Manufacturing and Nano-Technology	
26	Materials Science	
27	Experimental Stress and Analysis	
28	Industrial Engineering	
29	Internal Combustion Engines	
30	Computer Aided Manufacturing	
31	Rigid body dynamics	

REPORT OF SURVEY:

Course survey and the 10 most preferred courses are highlighted with larger, bold and blue colored fonts. Some important points are
mentioned below.

1. Page one is for Mechanical Engineering Courses. It had total of 32 entries among which two were discarded.

2. Page two is for Civil Engineering Courses. It had a total of 5 entries.

3. In the survey, it was asked to choose 10 courses and rank them from 1 to 10 (1=most preferred, 10=least preferred).

4. While compiling, anytime a course did not get a preference a large number (=30 in this case) was assigned to the course.

5. **The scores were then averaged and then sorted in ascending order. So, 10 lowest scoring courses are the most preferred ones**.

6. Sl. No. in the left most column corresponds to the Sl. No. of the courses listed in the documents circulated while conducting the survey.

Course Survey for Mechanical Engineering

Sl. No	Course Title	Average Score
1	**Heat and Mass Transfer**	6.93103
3	**Theory of Machines and Mechanisms**	8.58621
4	**Manufacturing Technology**	13.3103
2	**Advanced Mechanics of Solids**	13.3448
29	**Internal Combustion Engines**	14.931
26	**Materials Science**	15.3448
6	**Fluid Machines**	15.4138
12	**Design of Machine Elements**	16.5517
16	**Machine Drawing (including AUTOCAD)**	17.6207
22	**Refrigeration and Air Conditioning**	18.6207
15	Theory of Vibrations	19.8276
19	Numerical Methods	21.2414
21	Steam and Gas Turbines	21.8276
5	Energy Systems	23.1379
11	Industrial Engineering	23.8276
17	Mechanical Measurement and Instrumentation	23.9655
24	Computer Aided Design	24.2069
30	Computer Aided Manufacturing	24.6207
9	Finite Element Analysis	25.1724
20	Machine Tools and Metal Cutting	25.2069
10	Computational Fluid Dynamics	25.4828
7	Control Theory	25.9655
28	Industrial Engineering	26.7241
13	Operations Research	26.7931
18	Robotics	27.8621
25	Nontradional Manufacturing and Nano-Technology	28.4483
14	Machining Science	28.5862
23	Tribology	29.3103
8	Automation	30
27	Experimental Stress Analysis	30

Number of entries = 30

Course Survey for Civil Engineering

Sl. No.	Course Title	Avg. Score
9	**Transport Engineering**	6
10	**Concrete Technology**	6.25
6	**Theory of Structures**	8.2
5	**Soil Mechanics**	9.2
7	**Design of Structures**	9.2
4	**Engineering Hydraulics**	11.2
1	**Surveying**	13.6
2	**Civil Engineering Materials**	15.2
11	**Environmental Engineering**	16.4
28	**Seismology and Eqrthquake Engineering**	16.8
3	Environment Quality and Pollution	20
13	Project Planning and Management	20.2
19	Irrigation Water Management, Drainage and Flood Control	24.4
25	Hydraulic Structures	24.6
27	Analysis and Design of Offshore Structures	24.8
30	River Engineering	25.2
12	Water Resources Engineering	25.4
15	Geotechnical Investigations and Practices	25.4
17	Pavement Engineering	25.6
20	Unit Operation and Process for Water Quality Control	25.8
21	Remotre Sensing	26
23	Earth and Earth Retaining Structures	26
8	Foundation Engineering	30
14	Construction Technology	30
16	Rock Engineering	30
18	Bridge Engineering	30
22	Model Analysis for Structures	30
24	Traffic Engineering and Management	30
26	Industrial Pollution and Control	30
29	Geoinformatics	30

Number of entries = 5

APPENDIX XI

M.TECH PROGRAM DETAILS:

• Degree types – Masters of Engineering (course intensive + project)
about 12 courses
Master of Technology (some courses + rigorous thesis)
about 6-8 courses + 2 semesters of thesis
MS by research (fewer courses + research)

• Mandatory courses – Higher mathematics; numerical analysis (FEM or CFD); stream wise mandatory courses < continuum mechanics, theory of elasticity, advanced fluid mechanics>

• Communication skills – technical writing, oral presentation (seminar).

MECHANICAL ENGINEERING:

• Specializations on offer – Thermal Science; Manufacturing; Machine Design
(sub-streams within this set)
Major research activity – NDT/NDE; computational fluid dynamics, heat transfer, manufacturing

CIVIL ENGINEERING

•Civil not offered in many institutes

Specializations: Environmental
Transportation
Geotechnical
Water resources
Structural
Seismic and Earthquake

Deficiencies seen:

Weak mathematics, knowledge of continuum mechanics/theory of elasticity, fundamental derivations of equations of equilibrium/motion, programming skills and knowledge of numerical analysis.

What needs to change?