

Model Curriculum for Undergraduate Degree Courses in Engineering & Technology

January 2018



Volume II

ALL INDIA COUNCIL FOR TECHNICAL EDUCATION
Nelson Mandela Marg, Vasant Kunj, New Delhi 110070
www.aicte-india.org

**MODEL CURRICULUM FOR
UNDERGRADUATE DEGREE
COURSES IN
ENGINEERING TECHNOLOGY**

January 7, 2018

(Volume II)

ALL INDIA COUNCIL FOR TECHNICAL EDUCATION



**ALL INDIA COUNCIL FOR TECHNICAL
EDUCATION Nelson Mandela Marg, Vasant Kunj, New Delhi—**

110 070

www.aicte-india.org



Prakash Javadekar
Minister of Human Resource Development
Government of India

Message

India is a diverse economy and students of today will be the young leaders of tomorrow. India is renowned in producing students of high calibre and it is necessary that our aspiring students are able to pursue the right education. As we are all aware that engineering education is gaining new heights and contributes a substantial share in the overall education system, the youngsters pursuing engineering studies need to be well equipped and updated with the latest technological trends and industrial requirements. This is possible only when the students undergo studies with an updated and evolving curriculum to match global scenario.

I congratulate AICTE for developing a model curriculum with the help of academic and industry experts for various disciplines of Undergraduate Degree courses in Engineering & Technology which will be available for Universities and Institutions. This adoption will be advantageous for the students to enhance their skills and employability. Introduction of mandatory Induction program for students belonging to diverse backgrounds to adjust themselves in the new environment of Engineering degree courses is praise worthy.

An initiative to be continued in future as well....

(Prakash Javadekar)



R. SUBRAHMANYAM, IAS
Special Secretary



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GOVERNMENT OF INDIA
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Message

The economic progress of a country is strongly linked to the quality of technical education in the country. In order to sustain the growth rates of the economy, the pool of technical talent needs to continue to grow. Our country has witnessed a significant increase in the number of engineering graduates coming out of the technical institutions. Notwithstanding that the quality of technical education has to be continuously enriched with implementation of various quality initiatives. Education is a very dynamic field and talking about our engineering graduates, in particular, have to be educated and trained keeping in view the employability and self-sustaining factor viz. start-ups. A revision of engineering curriculum was a need of the hour and AICTE has developed latest Model curriculum for various undergraduate degree engineering disciplines. Kudos to AICTE and the Committees and teams who have immensely contributed and prepared a model curriculum for the benefit of the institution, the faculty and engineering students who are the key beneficiaries.

Revision of curriculum is not a stand-alone measure for bringing in reforms in technical education and will also be supported by various other initiatives. A need for industry-institute interaction and internship of students in an industry will definitely help students to learn and develop good communications skills and team work management. An appreciation of the fact that induction program for students and other mandatory non-credit courses along with an internship for students are a part of this curriculum. I hope that AICTE will ensure the revision of this model curriculum on regular basis and this updation will certainly help students achieve better employability; start-ups and other avenues for higher studies.


R. SUBRAHMANYAM





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Message

The quality of technical education depends on various factors ; outcome based socially and industrially relevant curriculum, good quality motivated faculty, teaching learning process, industry internships, evaluation of students based on desired outcomes among others. In engineering education, IITs have been a sterling example not only in India but have become a global brand. Therefore, it was of imperative that a revised AICTE model curriculum be prepared by best faculty drawn from IITs, keeping in view the latest industry trends and market requirements in all major engineering subjects and be made available to all universities and engineering institutions in the country. With the support of Ministry of Human Resource Development, AICTE constituted subject-wise heads of the committees from IITs with respective team of 2-3 academic experts along with industry expert to revise the model curriculum of undergraduate engineering courses. Similar exercise is done for programmes at Diploma and PG level in engineering, MBA, PGDM, Pharmacy, Architecture, etc.

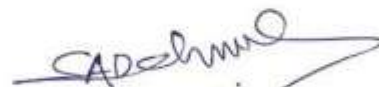
The revised model UG curriculum in engineering has been designed where number of credits have been reduced to 160 credits with a core comprising basic sciences and engineering having focus on fundamentals, discipline level significant courses and ample opportunity for the students to take electives both from the discipline and cross disciplines, provision for internship to understand the industry requirements, have hands-on experience and to pursue project work in their final year relevant to industry. This will allow the students to develop a problem solving approach to meet the challenges in future. As a major initiative by AICTE, a three week mandatory induction program for students has also been designed to be offered right at the commencement of the first year and classes will begin after this induction program. Its purpose is to make the students feel comfortable in their new environment, open them up, set a healthy daily routine, create bonding in the batch as well as between faculty and students,

develop awareness, sensitivity and understanding of the self, people around them, society at large, and nature.

The heads of the committee along with their teams have prepared the model curriculum for respective engineering disciplines. It is with great pleasure we thank each Head of the Committee along with their team of academic and industry experts who have developed and revised the model curriculum for major engineering disciplines. To enhance employability ratio and also enable youngsters to become job creators, the academic and industry experts have accordingly designed the scheme and syllabi. AICTE is thankful to Prof. Rajeev Sangal, Director (IIT-BHU) and his team for developing a Guide to induction program and mandatory non-credit courses such as constitution of India and environment science and engineering. AICTE also acknowledges Bharatiya Vidya Bhawan for developing mandatory non-credit course on Essence of Indian Traditional Knowledge.

The institutions/ universities in India are requested to adopt this "Model Curriculum" for various engineering disciplines. This is a suggestive curriculum and the concerned university/institution is allowed flexibility in readjustment of courses /credits within the overall credit structure of 160 credits in an undergraduate degree program.

AICTE places on record special thanks to Shri R. Subrahmanyam, Special Secretary, MHRD for providing guidance and support throughout the revision of the curriculum.



(Prof. Anil D. Sahasrabudhe)

PREFACE

There has been a concern about quality of technical education in India although in terms of access and equity, India has done very well. AICTE is mandated for planned and coordinated development of Technical Education; regulate proper maintenance of norms & standards and expansion of technical Education with Quality. Accordingly, AICTE in its 49th meeting of the Council held on 14.3.2017 approved a package of measures for improving quality of technical education in the country. Revision of Curriculum, Mandatory Internship and Induction Program were amongst the few major quality initiatives taken by AICTE.

AICTE, in consultation with MHRD constituted subject-wise Heads of the Committees with a respective team of academic experts along with industry expert to draft the model curriculum of UG engineering courses along with Induction Program for students.

During the meetings held for developing model curriculum for undergraduate engineering courses, a concern was shared that in the present system, the first year syllabus is heavily loaded and it is of utmost importance that the students entering into the first year of an engineering course should feel at ease by lowering the burden of syllabus and credits. This is necessary for a student to acclimatize to the new environment of a college and to create a bonding between the teacher and a student. An idea to introduce induction program in the curriculum to equip the students with communication skills, and get them acquainted with the culture of institution and human values was formalized. A student has to undergo this induction program after joining the institute and before the commencement of classes. Normal classes of the engineering program shall begin after the students have undergone a three-weeks induction program. The Induction program for students comprises of Physical activities; Learning an art form; Literature & Cinema; Social Awareness; Lectures & Visits; Universal Human Values; Familiarization to Department/Branch, College & Innovations. To sensitize on the need of induction program, one-day workshops for Principals/ Directors/ Promoters of Society/Trust/Institutions were held at Hyderabad, Bangalore, Mumbai, Kolkata and Delhi. Subsequently, five-day Teacher Training workshops for Student induction were also held at Hyderabad, Varanasi and Pune.

Also, AICTE has made 6-8 weeks summer internships mandatory before completion of under graduation. This will equip the students with practical understanding and training about industry practices in a suitable industry or organization.

A novel concept of Virtual Laboratories has also been introduced in the Model Curriculum. MHRD has successfully completed two phases of project under NPTEL, to develop Virtual Labs through a consortium headed by IIT Delhi. During these phases, more than 180 labs were developed, comprising of more than 1700 experiments, in different domains of engineering. These experiments are field tested through various nodal centres across the country. The Virtual Labs, essentially comprise of a user-friendly graphical front. It would be a far enriching experience to use virtual labs and learn at one's own pace and time. A student can even learn the skills

which are not part of the curriculum but required as professionals to take up new challenges. A chapteron 'Virtual Laboratories: A new way of Learning' is a part of this Model Curriculum.

It was also felt that students should get holistic education which has components of sports, physical activities, values and ethics.

The respective Heads of the Committees & teams discussed the existing system prevalent in engineering colleges, industry requirements and market trends, employability, problem solving approach, need for life long learning and after due deliberations, the scheme and syllabus for various engineering disciplines have been formalized. Salient features of this model curriculum are enumerated below:

- i.** Induction program has been made a part of this Model Curriculum.
- ii.** Model Curriculum has been designed in such a way that it encourages innovation and research as total number of credits have been reduced and many new courses have been incorporated in consultation with industry experts.
- iii.** The revised Model Curriculum has been designed where the students can understand the industry requirements and have hands-on experience. The students will develop a problem solving approach and will be able to meet the challenges of future.
- iv.** It is also understood that different engineering disciplines should have some flexibility in being different. All engineering disciplines cannot be made to conform to a fixed structure. Though, AICTE has compiled a common first year scheme and syllabi for engineering disciplines, the concerned Institution/ University may adjust the scheme and courses as per the requirement of particular Institute and local needs. However, the total credit structure of 160 credits should not be disturbed. The institutions/ universities in India are requested to adopt this "Model Curriculum" for various undergraduate degree engineering disciplines.
- v.** Courses on Constitution of India, Environment Science/Engg. and Essence of India Traditional Knowledge have also been included in the Curriculum.
- vi.** A novel concept of Virtual laboratories has been introduced in the model curriculum.
- vii.** Curriculum on Entrepreneurship is included to support AICTE's start-up policy.
- viii.** In some disciplines, courses have been mentioned in the scheme, it is left to the University/Institution to frame the detailed syllabus as per their need or can find the same in the AICTE model curriculum of some other disciplines in this booklet.
- ix.** AICTE will ensure the revision of the model curriculum on regular basis and this updation will certainly help students to achieve better employability; start-ups and other avenues for higher studies.

ACKNOWLEDGEMENT

The development of an outcome based Model Curriculum for Undergraduate degree courses in Engineering & Technology is a result of thoughtful deliberations at various stages of dedicated and specialized experts. This model curriculum has been framed to meet the expectations of an academically challenging environment, develop problem solving skills by students, align with current standards and to enrich the students learning to make them self-enablers and/or match job requirements on successful completion of their degree.

I wish to acknowledge all our esteemed experts who have been involved in the process of developing this outcome based model curriculum for various disciplines of undergraduate courses for adoption at various engineering Institutions and Universities. We are thankful to our Heads of the committees of different branches Prof. Anurag Mehra; Dr. D.N. Singh; Dr. R.K. Shevgaonkar; Prof. T.Sundararajan; Prof. Prathap Haridoss; Prof. Anupam Basu; Dr Anil Kulkarni; Prof. Bhaba K. Sarma; Prof. B. L. Tembe and Prof. Manoj Harbola with their team of Academic and Industry experts who were devotedly committed towards framing this model curriculum for various engineering disciplines. We are thankful to Prof. Rajneesh Arora, Chairman NCC-IP and his team for developing Model Guide to the mandatory induction program. We also thank Prof. Rajeev Sangal, Former Director (IIT-BHU) and his team for developing humanities courses. AICTE also acknowledges Bharatiya Vidya Bhawan for developing mandatory course on Essence of Indian Knowledge Tradition.

A novel concept of Virtual Labs. has been introduced in the Model curriculum to provide remote-access to Labs in various disciplines of Science and Engineering. I am extremely thankful to Prof. S.D. Agashe for preparing contents of Virtual Laboratories for various engineering disciplines.

I am greatly gratified to Shri R. Subrahmanyam, Special Secretary, MHRD for his supervision, contribution, guidance and support throughout the development of this model curriculum.

Special thanks and gratitude to Prof. Anil D. Sahasrabdhe, Chairman; Prof M.P. Poonia, Vice Chairman and Prof. A.P. Mittal, Member Secretary, AICTE who all have been instrumental and encouraging throughout the process of developing this model curriculum.

I like to appreciate the officers and officials of Policy & Academic Planning Bureau, in particular the dedication put in by Ms. Neera Kakkar by compiling the inputs from the experts and coordinating the whole process.

Last, but not the least, I also sincerely thank all officers and officials of AICTE, who have contributed in one way or other for the development of this Model curriculum.

Thanking all once again and seeking continued support.....



(Prof. Rajive Kumar)

Adviser-I

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Subject-wise Committees for Model Curriculum of Under Graduate Degree Engineering:

AICTE places on record its appreciation and thankfulness to the respective Heads of Committee along with their team of academic experts and industry experts:

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12. Essence of Indian Knowledge Tradition (Part 1 and 2)

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13. Prof. S.D. Agashe, Professor (Instrumentation & Control Engg.), College of Engineering, Pune

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**UPDATION/ERRATA
in
Model Curriculum for Undergraduate Degree Courses in
Engineering & Technology**

**January 2018 (Volume-II)
(As per Inputs of Experts)**

1. Please refer to-**Chemical Engineering syllabus (chapter 2)- Contents of BS-107 Chemistry-II (Basic Science Course) included.**[Page No. 20]
2. Please refer to curriculum of **Humanities, Social Science including Management courses (HSMC)**
 - (i) Para 6.1 - Human Values courses is updated. [Page No. 124]
 - (ii) Course Code HSMC (HU-102) may be read as UHV –II (H-102) along with the following:-
 - a. Name of the course ‘Universal Human Values-II: Self, Society and Nature’ is re-named as **“Universal Human Values-II: Understanding Harmony and Ethical Human Conduct”**. [PageNo. 166]

Addendum

in

Model Curriculum for Undergraduate Degree Course in
Engineering & Technology

January 2018 (Volume-I)

(As per Inputs of Experts)

- The course Universal Human Values-II: Understanding Harmony and Ethical Human Conduct added in the **Humanities, Social Science including Management courses (HSMC)** which is carrying 03 credits.
- This is **compulsory** subject for all **UG Degree Course in Engineering & Technology**, with 03 exclusive credits. Hence the overall credits of curriculum are 163 credits instead of 160 credits.
- It is recommended to offer either in 1st, 2nd, 3rd or 4th Semester.

Course code	UHV-II or HSMC (H-102)				
Category	Universal Human Values (UHV)				
Course Title	UNIVERSAL HUMAN VALUES-II: UNDERSTANDING HARMONY and ETHICAL HUMAN CONDUCT				
Scheme and Credits	L	T	P	C	Semester 1, 2, 3 or 4
	2	1	0	3	
Pre-requisites (if any)	None. Desirable – UHV-I: Universal Human Values-Introduction				

1-COURSES ON HUMAN VALUES

During the Induction Program, students would get an initial exposure to human values through Universal Human Values-I. This exposure is to be augmented by this compulsory full semester foundation course.

Objectives of UHV-II Course

This introductory course input is intended:

1. To help the students appreciate the essential complementarity between 'VALUES' and 'SKILLS' to ensure sustained happiness and prosperity which are the core aspirations of all human beings.
2. To facilitate the development of a Holistic perspective among students towards life and profession as well as towards happiness and prosperity based on a correct understanding of the Human reality and the rest of existence. Such a holistic perspective forms the basis of Universal Human Values and movement towards value-based living in a natural way.
3. To highlight plausible implications of such a Holistic understanding in terms of ethical human conduct, trustful and mutually fulfilling human behaviour and mutually enriching interaction with Nature.

Thus, this course is intended to provide a much-needed orientational input in value education to the young enquiring minds.

Salient Features of the Course

The salient features of this course are:

1. It presents a universal approach to value education by developing the right understanding of reality (i.e. a worldview of the reality "as it is") through the process of self-exploration.
2. The whole course is presented in the form of a dialogue whereby a set of proposals about various aspects of the reality are presented and the students are encouraged to self-explore the proposals by verifying them on the basis of their natural acceptance within oneself and validate experientially in living.
3. The prime focus throughout the course is toward affecting a qualitative transformation in the life of the student rather than just a transfer of information.
4. While introducing the holistic worldview and its implications, a critical appraisal of the prevailing notions is also made to enable the students discern the difference on their own right.

Course Methodology

1. The methodology of this course is explorational and thus universally adaptable. It involves a systematic and rational study of the human being vis-à-vis the rest of existence.
2. The course is in the form of 28 lectures (discussions) and 14 practice sessions.
3. It is free from any dogma or value prescriptions.
4. It is a process of self-investigation and self-exploration, and not of giving sermons. Whatever is found as truth or reality is stated as a proposal and the students are facilitated to verify it in their own right, based on their Natural Acceptance and subsequent Experiential Validation – the whole existence is the lab and every activity is a source of reflection.
5. This process of self-exploration takes the form of a dialogue between the teacher and the students to begin with, and then to continue within the student in every activity, leading to continuous self-evolution.
6. This self-exploration also enables them to critically evaluate their pre-conditionings and present beliefs.

2-COURSE TOPICS

The course has **28 lectures** and **14 tutorials** in 5 modules. The lectures and tutorials are of 1-hour duration. Tutorial sessions are to be used to explore and practice what has been proposed during the lecture sessions.

The Teacher's Manual provides the outline for lectures as well as practice sessions. The teacher is expected to present the issues to be discussed as propositions and encourage the students to have a dialogue.

The syllabus for the lectures and practice sessions is given below:

Module 1 – Introduction to Value Education (6 lectures and 3 tutorials for practice session)

Lecture 1: Right Understanding, Relationship and Physical Facility (Holistic Development and the Role of Education)

Lecture 2: Understanding Value Education

Tutorial 1: Practice Session PS1 *Sharing about Oneself*

Lecture 3: Self-exploration as the Process for Value Education

Lecture 4: Continuous Happiness and Prosperity – the Basic Human Aspirations

Tutorial 2: Practice Session PS2 *Exploring Human Consciousness*

Lecture 5: Happiness and Prosperity – Current Scenario

Lecture 6: Method to Fulfil the Basic Human Aspirations

Tutorial 3: Practice Session PS3 *Exploring Natural Acceptance*

Expected outcome:

The students start exploring themselves: get comfortable with each other and with the teacher; they start appreciating the need and relevance for the course.

The students start finding that technical education without study of human values can generate more problems than solutions. They also start feeling that lack of understanding of human values is the root cause of most of the present-day problems; and a sustained solution could emerge only through understanding of value-based living. Any solution brought out through fear, temptation of dogma will not be sustainable.

The students are able to see that verification on the basis of natural acceptance and experiential validation through living is the only way to verify right or wrong, and referring to any external source like text or instrument or any other person cannot enable them to verify with authenticity; it will only develop assumptions.

The students are able to see that their practice in living is not in harmony with their natural acceptance most of the time, and all they need to do is to refer to their natural acceptance to overcome this disharmony.

The students are able to see that lack of right understanding leading to lack of relationship is the major cause of problems in their family and not the lack of physical facility in most of the cases, while they have given higher priority to earning of physical facility in their life giving less value to or even ignoring relationships and not being aware that right understanding is the most important requirement for any human being.

Module 2 – Harmony in the Human Being (6 lectures and 3 tutorials for practice session)

Lecture 7: Understanding Human being as the Co-existence of the Self and the Body

Lecture 8: Distinguishing between the Needs of the Self and the Body

Tutorial 4: Practice Session PS4 *Exploring the difference of Needs of Self and Body*

Lecture 9: The Body as an Instrument of the Self

Lecture 10: Understanding Harmony in the Self

Tutorial 5: Practice Session PS5 *Exploring Sources of Imagination in the Self*

Lecture 11: Harmony of the Self with the Body

Lecture 12: Programme to ensure self-regulation and Health

Tutorial 6: Practice Session PS6 *Exploring Harmony of Self with the Body*

Expected outcome:

The students are able to see that they can enlist their desires and the desires are not vague. Also they are able to relate their desires to 'I' and 'Body' distinctly. If any desire appears related to both, they are able to see that the feeling is related to I while the physical facility is related to the body. They are also able to see that 'I' and Body are two realities, and most of their desires are related to 'I' and not body, while their efforts are mostly centred on the fulfilment of the needs of the body assuming that it will meet the needs of 'I' too.

The students are able to see that all physical facility they are required for a limited time in a limited quantity. Also, they are able to see that in case of feelings, they want continuity of the naturally acceptable feelings and they do not want feelings which are not naturally acceptable even for a single moment.

The students are able to see that activities like understanding, desire, thought and selection are the activities of 'I' only the activities like breathing, palpitation of different parts of the body are fully the activities of the body with the acceptance of 'I' while the activities they do with their sense organs like hearing through ears, seeing through eyes, sensing through touch, tasting through tongue and smelling through nose or the activities they do with their work organs like hands, legs etc. are such activities that require the participation of both 'I' and body.

The students become aware of their activities of 'I' and start finding their focus of attention at different moments. Also they are able to see that most of their desires are coming from outside (through preconditioning or sensation) and are not based on their natural acceptance

The students are able to list down activities related to proper upkeep of the body and practice them in their daily routine. They are also able to appreciate the plants wildly growing in and around the campus which can be beneficial in curing different diseases.

Module 3 – Harmony in the Family and Society (6 lectures and 3 tutorials for practice session)

Lecture 13: Harmony in the Family – the Basic Unit of Human Interaction

Lecture 14: 'Trust' – the Foundational Value in Relationship

Tutorial 7: Practice Session PS7 *Exploring the Feeling of Trust*

Lecture 15: 'Respect' – as the Right Evaluation

Tutorial 8: Practice Session PS8 *Exploring the Feeling of Respect*

Lecture 16: Other Feelings, Justice in Human-to-Human Relationship

Lecture 17: Understanding Harmony in the Society

Lecture 18: Vision for the Universal Human Order

Tutorial 9: Practice Session PS9 *Exploring Systems to fulfil Human Goal*

Expected outcome:

The students are able to note that the natural acceptance (intention) is always for living in harmony, only competence is lacking! We generally evaluate ourselves on the basis of our intention and others on the basis of their competence! We seldom look at our competence and others' intention as a result we conclude that I am a good person and other is a bad person.

The students are able to see that respect is right evaluation, and only right evaluation leads to fulfilment in relationship. Many present problems in the society are an outcome of differentiation (lack of understanding of respect), like gender biasness, generation gap, caste conflicts, class struggle, dominations through power play, communal violence, clash of isms and so on so forth. All these problems can be solved by realizing that the other is like me as he has the same natural acceptance, potential and program to ensure a happy and prosperous life for them and for others through he may have different body, physical facility or beliefs.

The students are able to use their creativity for education children. The students are able to see that they can play a role in providing value education for children. They are able to put in simple words the issues that are essential to understand for children and comprehensible to them. The students are able to develop an outline of holistic model for social science and compare it with the existing model.

Module 4 – Harmony in the Nature/Existence (4 lectures and 2 tutorials for practice session)

Lecture 19: Understanding Harmony in the Nature

Lecture 20: Interconnectedness, self-regulation and Mutual Fulfilment among the Four Orders of Nature

Tutorial 10: Practice Session PS10 *Exploring the Four Orders of Nature*

Lecture 21: Realizing Existence as Co-existence at All Levels

Lecture 22: The Holistic Perception of Harmony in Existence

Tutorial 11: Practice Session PS11 *Exploring Co-existence in Existence*

Expected outcome:

The students are able to differentiate between the characteristics and activities of different orders and study the mutual fulfilment among them. They are also able to see that human beings are not fulfilling to other orders today and need to take appropriate steps to ensure right participation (in terms of nurturing, protection and right utilization) in the nature.

The students feel confident that they can understand the whole existence; nothing is a mystery in this existence. They are also able to see the interconnectedness in the nature, and point out how different courses of study relate to the different units and levels. Also, they are able to make out how these courses can be made appropriate and holistic.

Module 5 – Implications of the Holistic Understanding – a Look at Professional Ethics (6 lectures and 3 tutorials for practice session)

Lecture 23: Natural Acceptance of Human Values

Lecture 24: Definitiveness of (Ethical) Human Conduct

Tutorial 12: Practice Session PS12 *Exploring Ethical Human Conduct*

Lecture 25: A Basis for Humanistic Education, Humanistic Constitution and Universal Human Order

Lecture 26: Competence in Professional Ethics

Tutorial 13: Practice Session PS13 *Exploring Humanistic Models in Education*

Lecture 27: Holistic Technologies, Production Systems and Management Models-Typical Case Studies

Lecture 28: Strategies for Transition towards Value-based Life and Profession

Tutorial 14: Practice Session PS14 *Exploring Steps of Transition towards Universal Human Order*

Expected outcome:

The students are able to present sustainable solutions to the problems in society and nature. They are also able to see that these solutions are practicable and draw roadmaps to achieve them.

The students are able to grasp the right utilization of their knowledge in their streams of Technology/Engineering/Management/any other area of study to ensure mutual fulfilment. E.g. mutually enriching production system with rest of nature.

The students are able to sincerely evaluate the course and share with their friends. They are also able to suggest measures to make the course more effective and relevant. They are also able to make use of their understanding in the course for the happy and prosperous family and society.

Guidelines and Content for Practice Sessions (Tutorials)

In order to connect the content of the proposals with practice (living), 14 practice sessions have been designed. The full set of practice sessions is available in the Teacher's Manual as well as the website.

Practice Sessions for Module 1 – Introduction to Value Education

- PS1 Sharing about Oneself
- PS2 Exploring Human Consciousness
- PS3 Exploring Natural Acceptance

Practice Sessions for Module 2 – Harmony in the Human Being

- PS4 Exploring the difference of Needs of Self and Body
- PS5 Exploring Sources of Imagination in the Self
- PS6 Exploring Harmony of Self with the Body

Practice Sessions for Module 3 – Harmony in the Family and Society

- PS7 Exploring the Feeling of Trust
- PS8 Exploring the Feeling of Respect
- PS9 Exploring Systems to fulfil Human Goal

Practice Sessions for Module 4 – Harmony in the Nature (Existence)

- PS10 Exploring the Four Orders of Nature
- PS11 Exploring Co-existence in Existence

Practice Sessions for Module 5 – Implications of the Holistic Understanding – a Look at Professional Ethics

- PS12 Exploring Ethical Human Conduct
- PS13 Exploring Humanistic Models in Education
- PS14 Exploring Steps of Transition towards Universal Human Order

As an example, PS 7 is a practice session in module 3 regarding trust. It is explained below:

PS 7: Form small groups in the class and in that group initiate dialogue and ask the eight questions related to trust. The eight questions are:

- 1a. Do I want to make myself happy?
- 1b. Am I able to make myself always happy?
- 2a. Do I want to make the other happy?
- 2b. Am I able to make the other always happy?

3a. Does the other want to make him happy?

4a. Does the other want to make me happy?

Intention (Natural Acceptance)

What is the answer?

3b. Is the other able to make him always happy?

4b. Is the other able to make me always happy?

Competence

What is the answer?

Let each student answer the questions for himself/herself and everyone else. Discuss the difference between intention and competence. Observe whether you evaluate your intention and competence as well as the others' intention and competence.

Expected outcome of PS 7: The students are able to see that the first four questions are related to our Natural Acceptance i.e. intention and the next four to our Competence. They are able to note that the intention is always correct, only competence is lacking! We generally evaluate ourselves on the basis of our intention and others on the basis of their competence! We seldom look at our competence and others' intention, as a result we conclude that I am a good person and other is a bad person.

3-READINGS:

3-1-Text Book and Teachers Manual

a. The Textbook

A Foundation Course in Human Values and Professional Ethics, R R Gaur, R Asthana, G P Bagaria, 2nd Revised Edition, Excel Books, New Delhi, 2019. ISBN 978-93-87034-47-1

b. The Teacher's Manual

Teachers' Manual for A Foundation Course in Human Values and Professional Ethics, R R Gaur, R Asthana, G P Bagaria, 2nd Revised Edition, Excel Books, New Delhi, 2019. ISBN 978-93-87034-53-2

3-2-Reference Books

1. JeevanVidya: EkParichaya, A Nagaraj, JeevanVidyaPrakashan, Amarkantak, 1999.
2. Human Values, A.N. Tripathi, New Age Intl. Publishers, New Delhi, 2004.
3. The Story of Stuff (Book).
4. The Story of My Experiments with Truth - by Mohandas Karamchand Gandhi
5. Small is Beautiful - E. F Schumacher.
6. Slow is Beautiful - Cecile Andrews
7. Economy of Permanence - J C Kumarappa
8. Bharat Mein Angreji Raj – Pandit Sunderlal
9. Rediscovering India - by Dharampal
10. Hind Swaraj or Indian Home Rule - by Mohandas K. Gandhi
11. India Wins Freedom - Maulana Abdul Kalam Azad
12. Vivekananda - Romain Rolland (English)
13. Gandhi - Romain Rolland (English)

4-MODE OF CONDUCT (L-T-P-C 2-1-0-3)

- Lecture hours are to be used for interactive discussion, placing the proposals about the topics at hand and motivating students to reflect, explore and verify them.
- Tutorial hours are to be used for practice sessions.
- While analysing and discussing the topic, the faculty mentor's role is in pointing to essential elements to help in sorting them out from the surface elements. In other words, help the students explore the important or critical elements.
- In the discussions, particularly during practice sessions (tutorials), the mentor encourages the student to connect with one's own self and do self-observation, self-reflection and self-exploration.
- Scenarios may be used to initiate discussion. The student is encouraged to take up "ordinary" situations rather than "extra-ordinary" situations. Such observations and their analyses are shared and discussed with other students and faculty mentor, in a group sitting.

Tutorials (experiments or practical) are important for the course. The difference is that the laboratory is everyday life, and practical are how you behave and work in real life. Depending on the nature of topics, worksheets, home assignment and/or activity are included. The practice sessions (tutorials) would also provide support to a student in performing actions commensurate to his/her beliefs. It is intended that this would lead to development of commitment, namely behaving and working based on basic human values.

It is recommended that this content be placed before the student as it is, in the form of a basic foundation course, without including anything else or excluding any part of this content. Additional content may be offered in separate, higher courses.

This course is to be taught by faculty from every teaching department.

Teacher preparation with a minimum exposure to at least one 8-day Faculty Development Program on Universal Human Values is deemed essential.

5-SUGGESTED ASSESSMENT:

This is a compulsory credit course. The assessment is to provide a fair state of development of the student, so participation in classroom discussions, self-assessment, peer assessment etc. will be used in evaluation.

Example:

Assessment by faculty mentor: 10 marks

Self-assessment: 10 marks

Assessment by peers: 10 marks

Socially relevant project/Group Activities/Assignments: 20 marks

Semester End Examination: 50 marks

The overall pass percentage is 40%. In case the student fails, he/she must repeat the course.

6-OUTCOME OF THE COURSE:

By the end of the course, students are expected to become more aware of themselves, and their surroundings (family, society, nature); they would become more responsible in life, and in handling problems with sustainable solutions, while keeping human relationships and human nature in mind.

They would have better critical ability. They would also become sensitive to their commitment towards what they have understood (human values, human relationship and human society). It is hoped that they would be able to apply what they have learnt to their own self in different day-to-day settings in real life, at least a beginning would be made in this direction.

Therefore, the course and further follow up is expected to positively impact common graduate attributes like:

1. Holistic vision of life
2. Socially responsible behaviour
3. Environmentally responsible work
4. Ethical human conduct
5. Having Competence and Capabilities for Maintaining Health and Hygiene
6. Appreciation and aspiration for excellence (merit) and gratitude for all

This is only an introductory foundational input. It would be desirable to follow it up by
a) Faculty-student or mentor-mentee programs throughout their time with the institution
b) Higher level courses on human values in every aspect of living.

MODEL CURRICULUM

for

UNDERGRADUATE DEGREE COURSES
IN

CHEMICAL ENGINEERING

(Engineering & Technology)

[January 2018]



ALL INDIA COUNCIL FOR TECHNICAL EDUCATION
Nelson Mandela Marg, Vasant Kunj, New Delhi 110 070
www.aicte-india.org



**All India Council for Technical Education
Model curriculum for
Undergraduate Degree Courses in Engineering & Technology**

CHEMICAL ENGINEERING

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All India Council for Technical Education
Model curriculum for
Undergraduate Degree Courses in Engineering & Technology

CHEMICAL ENGINEERING

Chapter-1
General, Course structure & Theme
&
Semester-wise credit distribution

A. Definition of Credit:

1 Hr. Lecture (L) per week	1 credit
1 Hr. Tutorial (T) per week	1 credit
1 Hr. Practical (P) per week	1.5 credits
2 Hours Practical(Lab)/week	1 credit

B. Range of credits - A range of credits from 150 to 160 for a student to be eligible to get Under Graduate degree in Engineering. A student will be eligible to get Under Graduate degree with Honours or additional Minor Engineering, if he/she completes an additional 20 credits. These could be acquired through MOOCs.

C. Structure of Undergraduate Engineering program :

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

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



D. Credit distribution in the First year of Undergraduate Engineering program :

	Lecture	Tutorial	Laboratory/Practical	Total credits
Chemistry –I	3	1	3	5.5
Physics	3	1	3	5.5
Maths-1	3	1	0	4
Maths -2	3	1	0	4
Programming for Problem solving	3	0	4	5
English	2	0	2	3
Engineering Graphics & Design	1	0	4	3
Workshop/ Practicals	1	0	4	3
Basic Electrical Engg.	3	1	2	5
*Biology	2	1	0	3
*Engg. Mechanics	3	1	0	4
*Maths-3	3	1	0	4

**These courses may be offered preferably in the 3rd semester & onwards.*

E. Course code and definition:

Course code	Definitions
BS	Basic Science courses
HSMC-HS	Humanities, Social Sciences including Management
ESC-GES	Engineering Science course
PCC-CS	Professional Core Courses
PEC-CSEL	Professional Elective Courses
OEC-OL	Open Elective course
MC	Mandatory Course
SI	Summer Internship
Proj	Project

BASIC SCIENCES COURSE [BSC] – BS

Sl. No	Code No.	Subject	Semester	Credits
1	BS101	Mathematics-I	1	4
2	BS102	Physics	1	4
3	BS103	Chemistry-I	1	4
4	BS104	Physics Lab	1	1.5
5	BS105	Mathematics-II	2	4
6	BS106	Chemistry Lab	2	1.5
7	BS107	Chemistry-II	3	4
8	BS108	Biology	3	4
Total Credits:				27

**ENGINEERING SCIENCE COURSES [ESC] - GES**

Sl. No	Code No.	Subject	Semester	Credits
1	GES101	Engineering Graphics	1	3
2	GES102	Thermodynamics-I	2	4
3	GES103	Electrical & Electronics Engineering	2	5
4	GES104	Computer Lab (Programming for Problem Solving)	2	5
5	GES105	Engineering & Solid Mechanics	3	4
6	GES106	Engineering Workshop	3	3
7	GES107	Material Science	4	3
Total Credits:				27

**HUMANITIES AND SOCIAL SCIENCES INCLUDING MANAGEMENT COURSES
[HSMC] HUMANITIES AND MANAGEMENT - HS**

Sl. No	Code No.	Subject	Semester	Credits
1	HS101	HASS-I (Communication Skills/ English)	1	3
2	HS102	HASS-II	4	3
3	HS103	HASS-III	5	3
4	HS104	HASS-IV	6	3
Total Credits:				12

PROFESSIONAL CORE COURSES [PCC] – CS

Sl. No	Code No.	Subject	Semester	Credits
1	CS101	Material & Energy Balance Computations	2	4
2	CS102	Transport Phenomena	3	4
3	CS103	Thermodynamics-II	3	4
4	CS104	Heat Transfer	4	4
5	CS105	Mass Transfer-I	4	3
6	CS106	Fluid Mechanics	4	4
7	CS107	Numerical Methods in Chemical Engineering	4	3
8	CS108	Chemical Reaction Engineering-I	5	4
9	CS109	Mass Transfer-II	5	3
10	CS110	Chemical Engineering Lab-I	5	2
11	CS111	Particle & Fluid Particle Processing	5	3
12	CS112	Chemical Reaction Engineering-II	6	3
13	CS113	Process Technology & Economics	6	3
14	CS114	Process Control	6	3
15	CS115	Chemical Engineering Lab-II	6	2
16	CS116	Design and Simulation Lab	7	3
17	CS117	Instrumentation & Control Lab	7	3
Total Credits:				55



PROFESSIONAL ELECTIVE COURSES [PEC] – CSEL

Sl. No	Code No.	Subject	Semester	Credits
1	CSEL	Elective – I	5	3
2	CSEL	Elective-II	6	3
3	CSEL	Elective-III	7	3
4	CSEL	Elective-IV	7	3
Total Credits:				12

OPEN ELECTIVE COURSES [OEC] – OL

Sl. No	Code No.	Subject	Semester	Credits
1	OL	Open Elective-I	5	3
2	OL	Open-Elective-II	6	3
3	OL	Open-Elective-III	7	3
4	OL	Open-Elective-IV	7	3
Total Credits:				12

SUMMER INDUSTRY INTERNSHIP [SI] PROJECT

Sl. No	Code No.	Subject	Semester	Credits
1		Summer Internship		3
2		Project	8	12
Total Credits:				15



**4 year Curriculum structure
Undergraduate Degree in Engineering & Technology**

**Branch / Course: Chemical Engineering
Total credits (4 year course) 160**

I. **Mandatory 3-week Student Induction Program** (Please refer **Appendix-A** for guidelines and details.)

II. **Semester-wise structure of curriculum**
[L= Lecture, T = Tutorials, P = Practicals & C = Credits]

**Semester I (First year)
Branch/Course Chemical Engineering**

Sl. No.	Category	Course Code	Course Title	Hours per week			Total contact hrs,	Credits
				Lecture	Tutorial	Practical		
1	Basic Science course	BS101	Mathematics – I	3	1	0	60	4
2	Basic Science course	BS102	Physics	3	1	0	60	4
3	Basic Science course	BS103	Chemistry – I	3	1	0	60	4
4	Humanities, Social Sciences including Management	HSMC- HS101	HASS-I (Communication skills/ English)	2	0	2	60	3



Sl. No.	Category	Course Code	Course Title	Hours per week			Total contact hrs,	Credits
				Lecture	Tutorial	Practical		
5	Engineering Science Courses	ESC- GES101	Engineering Graphics	1	0	4	75	3
6	Basic Science course	BS104	Physics Lab	0	0	3	48	1.5
Total credits							19.5	

Semester II (First year]
Branch/Course: Chemical Engineering

Sl. No.	Category	Code	Course Title	Hours per week			Total contact hrs,	Credits
				Lecture	Tutorial	Practical		
1	Basic Science courses	BS105	Mathematics – II	3	1	0	60	4
2	Engineering Science Courses	ESC- GES102	Thermodynamics – I	3	1	0	60	4
3	Engineering Science Courses	ESC- GES103	Electrical & Electronics Engineering	3	1	2	60	5
4	Professional Core Courses	PCC- CS101	Material & Energy Balance Computations	3	1	0	60	4
5	Engineering Science Courses	ESC- GES104	Computers Lab (Programming for Problem Solving)	3	0	4	48	5
6	Basic Science courses	BS106	Chemistry Lab.	0	0	3	48	1.5
Total credits							23.5	



**Semester III (Second year] Curriculum
Branch/Course Chemical Engineering**

Sl. No.	Category	Code	Course Title	Hours per week			Total contact hrs,	Credits
				Lecture	Tutorial	Practical		
1	Engineering Science Course	ESC- GES 105	Engineering and Solid Mechanics	3	1	0	60	4
2	Basic Science Course	BS107	Chemistry - II	3	1	0	60	4
3	Professional Core Courses	PCC- CS102	Transport Phenomena	3	1	0	60	4
4	Basic Science course	BS108	Biology	3	1	0	60	4
5	Professional Core courses	PCC- CS103	Thermodynamics – II	3	1	0	60	4
6	Engineering Science Course	ESC- GES106	Engineering Workshop	1	0	4	75	3
							Total credits	23

**Semester IV (Second year) Curriculum
Branch/Course: B. Chem. Eng.**

S. No.	Type of course	Code	Course Title	Hours per week			Total contact hours	Credits
				Lecture	Tutorial	Practical		
1	Professional Core Courses	PCC- CS104	Heat Transfer	3	1	0	60	4
2	Professional Core Courses	PCC- CS105	Mass Transfer- I	3	0	0	45	3
3	Professional Core Courses	PCC- CS106	Fluid Mechanics	3	1	0	60	4
4	Engineering Science Courses	ESC- GES107	Materials Science	3	0	0	45	3



S. No.	Type of course	Code	Course Title	Hours per week			Total contact hours	Credits
5	Humanities And Social Sciences Including Management Courses	HSMC-HS102	HASS- II	3	0	0	45	3
6	Professional Core Courses	PCC-CS107	Numerical Methods in Chemical Engineering	2	0	2	60	3
7	Mandatory non-credit course	MC	Environmental sciences	-	-	-		0
Total credits							20	

**Semester V (Third year] Curriculum
Branch/Course Chemical Engineering**

Sl. No	Category	Code	Course Title	Hours per week			Total contact hrs.	Credits
				Lecture	Tutorial	Practical		
1	Professional Core Courses	PCC-CS108	Chemical Reaction Engineering- I	3	1	0	60	4
2	Professional Core Courses	PCC-CS109	Mass Transfer- II	3	0	0	45	3
3	Professional Elective Courses	PEC-CSEL	Core Elective- I	3	0	0	45	3
4	Open Elective Courses	OEC-OL	Open Elective- I	3	0	0	45	3
5	Humanities And Social Sciences Including Management Courses	HSMC-HS103	HASS- III	3	0	0	45	3
6	Professional Core Courses	PCC-CS110	Chemical Engineering Lab- I	0	0	4	48	2



Sl. No	Category	Code	Course Title	Hours per week			Total contact hrs.	Credits
7	Professional Core Courses	PCC-CS111	Particle & Fluid Particle Processing	3	0	0	45	3
8	Mandatory course	MC	Slot for MC [Constitution of India/ Essence of Indian Knowledge Tradition]	-	-	-	-	0
Total credits							21	

**Semester VI (Third year) Curriculum
Branch/Course Chemical Engineering**

S. No.	Type of course	Code	Course Title	Hours per week			Total contact hours	Credits
				Lecture	Tutorial	Practical		
1	Professional Core Courses	PCC-CS112	Chemical Reaction Engineering- II	3	0	0	45	3
2	Professional Core Courses	PCC-CS113	Process Technology & Economics	3	0	0	45	3
3	Professional Elective Courses	PEC-CSEL	Core Elective- II	3	0	0	45	3
4	Professional Core Courses	PCC-CS114	Process Control	3	0	0	45	3
5	Humanities And Social Sciences Including Management Courses	HSMC-HS104	HASS- IV	3	0	0	45	3
6	Professional Core Courses	PCC-CS115	Chemical Engineering Lab- II	0	0	4	48	2
7	Open Elective Courses	OEC-OL	Open Elective- II	3	0	0	45	3
Total credits							20	

Students undergo Summer Internship for a period of 12 weeks.	3 credits
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**Semester VII (Fourth year] Curriculum
Branch/Course Chemical Engineering**

S. No.	Type of course	Code	Course Title	Hours per week			Total contact hours	Credits
				Lecture	Tutorial	Practical		
1	Professional Elective Courses	PEC-CSEL	Core Elective-III	3	0	0	45	3
2	Professional Core Courses	PCC-CS116	Design & Simulation Lab	1	0	4	75	3
3	Professional Core Courses	PCC-CS117	Instrumentation & Control Lab	1	0	4	75	3
4	Professional Elective Courses	PECCSEL	Core Elective-IV	3	0	0	45	3
5	Open Elective Courses	OEC-OL	Open Elective-III	3	0	0	45	3
6	Open Elective Courses	OEC-OL	Open Elective-IV	3	0	0	45	3
Total credits							18	

**Semester VIII (Fourth year] Curriculum
Branch/Course Chemical Engineering**

Sl. No.	Category	Code	Course Title	Hours per week			Credits
				Lecture	Tutorial	Practical	
1	Summer Industry Internship Project	Proj	Project	-	-	-	12
Total credits							12

TOTAL CREDITS – 160

CHAPTER 2

DETAILED 4-YEAR CURRICULUM CONTENTS

Undergraduate Degree in Engineering & Technology

Branch/Course: CHEMICAL ENGINEERING

BASIC SCIENCE COURSES



BS101	Mathematics - I	3L:1T:0P	4 credits
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Objectives

Basic concepts of linear algebra and vector calculus.

1. Linear Algebra: Matrices, Vectors, Determinants, Linear Systems(12L + 4T)

- Matrices, Vectors: Addition and Scalar Multiplication
- Matrix Multiplication
- Linear Systems of Equations, Gauss Elimination
- Linear Independence. Rank of a Matrix. Vector Space
- Solutions of Linear Systems: Existence, Uniqueness
- Determinants, Cramer's Rule
- Inverse of a Matrix. Gauss-Jordan Elimination

2. Linear Algebra: Matrix Eigenvalue Problems (9L + 3T)

- Eigenvalues, Eigenvectors
- Applications of Eigenvalue Problems
- Symmetric, Skew-Symmetric, and Orthogonal Matrices

3. Vector Differential Calculus. Grad, Div, Curl (12L + 4T)

- Vectors in 2-Space and 3-Space
- Inner Product (Dot Product), Vector Product (Cross Product)
- Vector and Scalar Functions and Fields, Derivatives
- Curves. Arc Length. Curvature
- Gradient of a Scalar Field, Directional Derivative
- Divergence of a Vector Field
- Curl of a Vector Field.

4. Integral Calculus. Integral Theorems(12L + 4T)

- Line Integrals, Path Independence of Line Integrals
- Green's Theorem in the Plane
- Surfaces for Surface Integrals
- Surface Integrals

Total 60 (L + T)

Course outcomes

Students will be able to solve

- System of linear algebraic equations
- Vector algebra, vector differential calculus and vector integral calculus



BS102	Physics	3L:1T:0P	4 credits
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Objectives:

Basic concepts of optics and its applications, electricity and magnetism, and quantum physics.

1. Optics and Fibre Optics (12L + 4T)

- Diffraction: Introduction to interference and example; concept of diffraction, Fraunhofer and Fresnel diffraction, Fraunhofer diffraction at single slit, double slit, and multiple slits; diffraction grating, characteristics of diffraction grating and its applications.
- Polarisation: Introduction, polarisation by reflection, polarisation by double refraction, scattering of light, circular and elliptical polarisation, optical activity.
- Fibre Optics: Introduction, optical fibre as a dielectric wave guide: total internal reflection, numerical aperture and various fibre parameters, losses associated with optical fibres, step and graded index fibres, application of optical fibres.
- Lasers: Introduction to interaction of radiation with matter, principles and working of laser: population inversion, pumping, various modes, threshold population inversion, types of laser: solid state, semiconductor, gas; application of lasers.

2. Electromagnetism and Magnetic Properties of Materials (15L + 5T)

- Laws of electrostatics, electric current and the continuity equation, laws of magnetism. Ampere's Faraday's laws. Maxwell's equations. Polarisation, permeability and dielectric constant, polar and non-polar dielectrics, internal fields in a solid, Clausius-Mossotti equation, applications of dielectrics.
- Magnetisation, permeability and susceptibility, classification of magnetic materials, ferromagnetism, magnetic domains and hysteresis, applications.

3. Quantum Mechanics (18L + 6T)

- Introduction to quantum physics, black body radiation, explanation using the photon concept, photoelectric effect, Compton effect, de Broglie hypothesis, wave-particle duality, Born's interpretation of the wave function, verification of matter waves, uncertainty principle, Schrodinger wave equation, particle in box, quantum harmonic oscillator, hydrogen atom.

Total 60 (L + T)

Course outcomes

Students will be familiar with

- Bragg's Law and introduced to the principles of lasers, types of lasers and applications
- Various terms related to properties of materials such as, permeability, polarization, etc.
- Some of the basic laws related to quantum mechanics as well as magnetic and dielectric properties of materials
- Simple quantum mechanics calculations



BS103	Chemistry – I	3L:1T:0P	4 credits
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Objectives

Concepts of quantum chemistry, bonding, stereochemistry, and those of Synthesis methodologies and reactivity of organic compounds.

1. Introduction to quantum theory for chemical systems: Schrodinger equation, Applications to Hydrogen atom, Atomic orbitals, many electron atoms (6L + 2T)

2. Chemical bonding in molecules:

MO theory, Structure, bonding and energy levels of bonding and shapes of many atom molecules, Coordination Chemistry, Electronic spectra and magnetic properties of complexes with relevance to bio-inorganic chemistry, organometallic chemistry (12L + 4T)

3. Introduction to Stereochemistry: Stereodescriptors – R, S, E, Z. Enantiomers and Diastereomers. Racemates and their resolution. Conformations of cyclic and acyclic systems. (6L + 2T)

4. Reactivity of organic molecules: factors influencing acidity, basicity, and nucleophilicity of molecules, kinetic vs. thermodynamic control of reactions (9L + 3T)

5. Strategies for synthesis of organic compounds: Reactive intermediates substitution, elimination, rearrangement, kinetic and thermodynamic aspects, role of solvents (12L + 4T)

Total 60(L+T)

Course outcomes

Students will be able to

- Appreciate quantum theory of chemical systems
- Appreciate aliphatic chemistry and stereochemistry
- Write simple mechanisms

BS104	Physics Lab	0L:0T:3P	1.5 credits
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Objectives

Physics lab provides students the first hand experience of verifying various theoretical concepts learnt in theory courses.

1. About 10 – 12 experiments to illustrate the concepts learnt in Physics (Number of lab. Hrs. 3 per experiment)

Suitable number of experiments from the following categories:

- Optics and its applications
- Electricity & Magnetism
- Quantum Mechanics

Total 48 lab. Hrs.

Laboratory outcomes

Students should be able to

- State various laws which they have studied through experiments
- Describe principles of optical fibre communication



BS105	Mathematics – II	3L:1T:0P	4 credits
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Objectives:

Basic concepts of transforms, ordinary and partial differential equations

Contents :

1. Transforms [6L + 2T]

- Laplace Transforms
- Fourier Series and Transforms

2. First-Order ODEs [9L + 3T]

- Basic Concepts
- Solutions of Separable ODEs, Exact ODEs, Linear ODEs
- Solving ODEs by Laplace Transforms

3. Second-Order Linear ODEs [9L + 3T]

- Homogeneous Linear ODEs of Second Order
- Euler-Cauchy Equations
- Wronskian
- Nonhomogeneous ODEs, Solution by Variation of Parameters

4. Series Solutions of ODEs, Special Functions [12L + 4T]

- Power Series Method
- Legendre.'s Equation, Legendre Polynomials
- Bessel's Equation, Bessel Functions
- Sturm-Liouville Problems, Orthogonal Functions

5. Partial Differential Equations (9L + 3T)

- Basic Concepts, Classification
- Solution of PDEs: Separation of Variables, Fourier Series, Laplace Transforms

Total 60(L+T)

Course outcomes

Students should be able to solve

- Simple first and second order ODE by Analytical methods
 - First and second order differential equations numerically
 - Partial differential equations numerically
 - Problems relating to Laplace transforms
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BS106	Chemistry Lab	0L:0T:3P	1.5 credits
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Objectives

Chemistry lab provides students the first hand experience of verifying various theoretical concepts learnt in theory courses.

1. About 10 – 12 experiments to illustrate the concepts learnt in Chemistry-I, Chemistry-II (No. of lab. Hours 4 per experiment).

Suitable number of experiments from the following categories:

- Identification of an organic compounds through group detection, physical constants (m.p and b.p)
- Synthesis of organic compounds involving reactions such as hydrogenation, oxidation, esterification, etc.
- Use of analytical instruments for characterization and identification of compounds
- Measurements of kinetics of simple reactions

Total 48 lab. Hrs

Course Outcomes

Students will be able to

- List steps for identifying simple organic compounds
 - Use different analytical instruments
 - Identify reaction rate parameters
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BS107	Chemistry-II	3L:1T:0P	4 credits
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Objectives:

Concepts related to homogeneous and heterogeneous catalysis, mechanisms of industrially important reactions, spectroscopic methods for identification of compounds.

Contents:

1. Homogeneous and Heterogeneous catalysis:
Homogeneous Lewis acid-base catalysts, organometallic catalysts and industrially examples.
Heterogeneous catalysts basic concepts and industrial examples. [6L+2T]
2. Mechanisms and recent advances (green chemistry, catalysis, etc.) of following processes:
Alkylation and acylation, e.g. alkylation of benzene, phenols, etc.
Halogenation, e.g. chlorination of toluene
Nitration and sulfonation, e.g. nitration, sulfonation of benzene, etc. [9L+3T]
3. Mechanisms and recent advances (green chemistry, catalysis, etc.) of following processes:
Hydrogenation and reductive alkylations, e.g. hydrogenation of nitrobenzene, reductive alkylation reactions of anilines, etc.
Oxidation, e.g. oxidation of xylenes, etc. [9L+3T]
4. Mechanisms and recent advances (green chemistry, catalysis etc.) of following processes:
Polymerization, e.g. polyethylene, polypropylene, polyester and nylon, etc. [9L+3T]
5. Analytical chemistry:
Statistical Aspects, Molecular and atomic spectroscopy method. [6L+2T]
6. Analytical chemistry: Thermal & Chromatographic methods. [6L+2T]

Total 60(L+T)

Course outcomes

Students taking the course will

- Get an understanding of the theoretical principles underlying molecular structure, bonding and properties.
- Know the fundamental concepts of structure and function in organic reactions, the use of kinetics and thermodynamics to elucidate mechanisms of reactions.
- Be able to predict reactivity patterns and propose reasonable mechanisms.



BS108	Biology	3L:1T:0P	4 credits
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Objectives

Students will be introduced to the basics of biology such as cell structure and functions, inheritance & evolution, basic concepts of genetics, and an introduction to microbiology

Contents:

1. Basics: Diversity of life, prokaryotes and eukaryotes, basic cell constituents and macromolecules. [6L + 1T]
2. Biochemistry: Metabolism (Catabolism and Anabolism) and Bioenergetics [12L + 3T]
3. Genetics: Basic principles of Mendel, molecular genetics, structure and function of genes and chromosomes, Transcription and Translation, gene expression and regulation. [12L + 3T]
4. Cell Biology: Macromolecules, membranes, organelles, cytoskeleton, signaling, cell division, differentiation, motility. [12L + 3T]
5. Microbiology: host-microbe interactions, physiology, ecology, diversity, and virology (6L + 2T)

Total 60 (L + T)

Course outcomes

Students will get insight into biology as a science, outlining the diversity, organization and fundamental principles of living systems.

ENGINEERING SCIENCE COURSES



ESC-GES101	Engineering Graphics	1L:0T:4P	3 credits
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Objectives

Students would be introduced to methods to aid visualisation of engineering objects and communicating the same to other professionals. This includes engineering drawings, CAD systems and tools for processing and presentation of time evolving systems in the form of animation, free- hand sketching of engineering objects and interpretation of drawings as a visualisation and communication tool. Design of simple assemblies would be involving theory of constraints, generation of assembly views from part drawings, animation of assemblies. Use of 3D models of rigid and soft systems in conjunction with physics engines for representation of time evolving system.

1. Instructions for graphic science and visualization (1L+1P)
2. Free hand sketching of isometric & orthographic views and interpretation of drawings (3L+3P)
3. Dimensioning, sectioning and datum planes. (4L+4P)
4. Constraints and assembly drawings (2L+2P)
5. Engineering animation including motion curves, coordinating multiple moving parts under joint-constraints and the notion and impact of lighting and camera (3L+3P)
6. Compositing and physics engines (gravity, collision, dynamics, fluid simulation (2L+2P)

Total 15L+15P* [*1L means one lecture turn (typically, 1 hour) and 1P means one practical turn (typically, 3-4 hours)].

Course outcomes

Students will be able to read drawing and can understand different views.

ESC-GES102	Thermodynamics-1	3L:1T:0P	4 credits
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Objectives:

Principles and application of first and second law of thermodynamics, and phase equilibria.

Contents:

1. Introduction- scope of thermodynamics, Dimensions and Units, Temperature, Pressure, Work, Energy, Heat [3L + 1T]
2. Energy conservation & first law of thermodynamics; State functions; Equilibrium; Phase Rule; Reversible process; Constant P, V, T processes; Mass and energy balances for open systems. [6L + 2T]



3. Phases, phase transitions, PVT behavior; description of materials – Ideal gas law, van der Waals, virial and cubic equations of state; Reduced conditions & corresponding states theories; correlations in description of material properties and behavior [6L + 2T]
4. Heat effects-latent heat, sensible heat, standard heats of formation, reaction and combustion. [3L + 1T]
5. Statements of the second law; Heat engines, Carnot's theorem,; Thermodynamic Temperature Scales; Entropy; Entropy changes of an ideal gas; Mathematical statement of the second law; Entropy balance for open systems; Calculation of ideal work, Lost work. (6L + 2T)
6. Thermodynamic property of fluids, Maxwell relations, 2-phase systems, graphs and tables of thermodynamic properties. (6L + 2T)
7. Application of thermodynamics to flow processes-pumps, compressors and turbines (3L + 1T)
8. Thermodynamic analysis of steam power plants; Rankine cycle; Internal combustion engine, Otto engine; Diesel engine; Jet engine. (6L + 2T)
9. The Carnot refrigerator; Vapor-compression cycle; Absorption refrigeration; Heat pump, Liquefaction processes.. (6L + 2T)

Total 60(L+T)

Suggested Text Books

1. J.M. Smith, H.C. Van Ness and M.M. Abbott, Introduction to Chemical Engineering Thermodynamics, 7th edition, McGraw-Hill International Edition, 2005.

Suggested References Books

1. M J Moran, H N Shapiro, D D Boettner and M B Bailey, Principles of Engineering Thermodynamics, 8th Edition, Willey .

Course outcomes

Students should be able to

- Apply mass and energy balances to closed and open systems
 - Evaluate the properties of non-ideal gases
 - Solve problems involving liquefaction, refrigeration and different power cycles.
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ESC-GES103	Electrical & Electronics Engineering	3L:1T:2P	5 credits
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Objectives

An insight to the importance of electrical energy in chemical plants. Basics of electricity, selection of different types of drives for a given application process. Basic insight into power supplies, instrumentation amplifiers in industries.

Contents :

1. Elements in an Electrical circuit: R, L, C, Diode, voltage and current sources [3L + 1T]

2. DC circuits, KCL, KVL, Network theorems, Mesh and nodal analysis [6L + 2T]

3. Step response in RL, RC, RLC circuits [3L+1T]

4. Phasor analysis of AC circuits [6L+2T]

5. Single-phase and 3-phase circuits. (3L+1T)

6. Two port networks, BJT, CE and small signal model, operational amplifiers, model and applications. (3L+1T)

7. Introduction to digital circuits (6L+2T)

8. Transformers: modelling and analysis. (6L+2T)

9. Energy in magnetic field. (3L+1T)

10. Electromechanical energy conversion: principles and examples (3L+1T)

11. Principles of measurement of voltage, current and power (3L+1T)

Total 60 (L+T)

Course outcomes

Students will be able to

- Understand the basic concepts of D.C., single phase and three phase A.C. supply and circuits, and solve basic electrical circuit problems
- Understand the basic concepts of transformers and motors used as various industrial drives
- Understand the concept of power factor improvement for industrial installations and concept of most economical power-factor



ESC-GES104	Computers Lab (Programming for Problem Solving)	3L:0T:4P	5 credits
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Objectives

To make students familiar with the use of computers for scientific calculations, use of programming languages and the logic for writing computer programs involving problems from Mathematics and Statistics, Physics, Chemistry.

1. About 10 – 12 assignments to be done using computers, such as: (No. of contact. Hrs : 4 per experiment, Lectures to cover material in sync)

- Organization of Computing Systems. Concepts of algorithms
- Basics of programming languages using, arrays, loops, if-else, switch case, functions
- Using the above for solving problems such as:
Curve fitting and regression, Data analysis and handling, linear and non-linear equations, etc.

Total 48 contact Hrs

Course outcomes

Students will be able to solve simple problems in statistics, chemistry and physics using programming languages.

ESC-GES105	Engineering and Solid Mechanics	3L:1T:0P	4 credits
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Objectives:

Students would be introduced to fundamentals of Engineering Mechanics with emphasis on force systems, axioms, dynamics of rigid bodies. Second part of the course would be an introduction to Solid Mechanics, and students would be introduced to basic concepts of mechanics of deformable media: concept of stress tensor, strain tensor, strain rates, constitutive relations, and applications to one/two dimensional problems.

Contents:

1. Introduction, Point Kinematics: Moving point in various coordinate systems (Cartesian, Cylindrical, Path) (3L+1T)
2. Rigid body kinematics: Translation and rotation, relative motion, angular velocity, General motion of a rigid body, General relative motion (6L+2T)
3. Equivalent force systems, Resultant forces, Linear and Angular Momentum, Laws of motion (Euler's Axioms), Free Body Diagrams, Dynamics of point mass models of bodies. (6L+2T)
4. Equilibrium of rigid bodies, distributed forces, Analysis of structures: Trusses, Forces in Beams: Shear Force and Bending Moment (9L+3T)



5. Frictional forces, Laws of Coulomb friction, impending motion (3L+1T)

6. Inertia tensor, Principal Moments of Inertia, Moment of momentum relations for rigid bodies, Euler's Equations of Motion (6L+2T)

7. State of stress at a point, equations of motion, principal stress, maximum shear stress, Concept of strain, strain displacement relations, compatibility conditions, principal strains, transformation of stress/strain tensor, state of plane stress/strain. (6L+2T)

8. Uniaxial stress and strain analysis of bars, thermal stresses, Torsion of circular bars and thin walled members, Bending of straight/curved beams, transverse shear stresses, deflection of beams, Buckling of columns (6L+2T)

Total 60(L+T)

Course outcomes

Students will be able to

- Understand the use of basic concepts of Resolution and composition of forces
- Analyse beams, truss or any engineering component by applying conditions of equilibrium
- List advantages and disadvantages of various geometric sections used in engineering design
- Understand the different stresses and strains occurring in components of structure
- Calculate the deformations such as axial, normal deflections under different loading conditions

ESC-GES106	Engineering Workshop	1L:0T:4P	3 credits
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Objectives:

The idea of this course is to understand the concepts involved in product realization by carrying out manufacturing shop exercises. Hands-on practice with manufacturing shop exercises and assembly leading to realization of a new product in a group. Students will also be introduced to the importance of manufacturing planning.

Contents:

1. Introduction to the course and its objectives; mandatory briefing on shop-floor safety. Introduction to all manufacturing forms, and introduction to basic tools (hand tools and power tools) (2L+2P)
2. Overview of engineering materials and forms in which they are commonly available as raw materials. Typical component manufacture with materials like wood. (2L+2P)
3. Overview of shape realization by manufacturing, measurement of manufactured parts. Associated with: Machine shop exercises- involving sawing, turning and drilling, milling, grinding and joining. Inspection of manufactured component using simple metrology instruments. (5L+5P)
4. Overview of computer numerically controlled machines Machine shop exercise using CNC - Part modeling, CNC program generation and cutting part on CNC milling machine (2L+2P)



5. Use of plastics and composites as engineering materials Practicals: Hands-on exercise involving plastics - use of vacuum forming, injection/compression molding, extrusion, ultrasonic welding of plastic components etc. (4L+4P)

Total 15L + 15P [* * 1L means one tutorial turn (typically, 1 hour) and 1P means one practical turn (typically, 3-4 hours)].

Course outcomes

Students will realize the importance of

- Manufacturing planning
- Computer numerically controlled machines

ESC-GES107	Material Science	3L:0T:0P	3 credits
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Objectives:

The objective of the course will be to give the students a basic introduction to the different classes of materials relevant to engineering in general, and Chemical Engineering in particular. The intent of the course will be to relate the underlying molecular structure of the materials to their physical and chemical properties, and their processing and performance characteristics.

Contents :

1. Introduction to materials, bonding between atoms: metallic bonding, ionic bonding, covalent bonding, Van der Waals bond, thermal expansion, elastic modulus and melting point of materials, Role of materials selection in design, structure-property-processing-performance relationships (4 contact hrs.)
2. Miller indices of directions and planes, packing of atoms inside solids, close-packed structures, structure of ceramics, ionic solids, glass and polymers, density of various materials. (4 contact hrs.)
3. Imperfections in solids: vacancies, equilibrium concentration of vacancies, interstitial and substitutional impurities in solids, dislocations, types and characteristics of dislocations, interfacial defects, stacking faults. (4 contact hrs.)
4. Structure of materials and Strength of Materials: Yield strength, tensile strength and ductility of materials: stress strain behaviour of metals, ceramics and polymers, tensile test, plastic deformation, necking, creep behaviour and fatigue (4 contact hrs.)
5. Semi-crystalline materials: Classification, structure and configuration of ceramics, polymers, copolymers, liquid crystals and amphiphiles (10 contact hrs.)



6. Non-crystalline/amorphous materials: Silicates, glass transition temperature, viscoelasticity (4 contact hrs.)
7. Polymer nano-composite materials: Nanocomposites, role of reinforcement-matrix interface strength on composite behavior(4 contact hrs.)
8. Corrosion, Degradation and Recycling(4 contact hrs.)
9. Biomaterials, material related to catalyst such as zeolites, silica etc. and other selected materials(4 contact hrs.)
10. Introduction to experimental techniques: XRD, NMR, PSA, etc. for material characterization highlighting links between molecular structure and macroscopic properties(3 contact hrs.)

Total 45L

Suggested Books

1. V. Raghavan Materials Science and Engineering: A First Course, 5th Edition Prentice Hall India, 2004.
2. S. Upadhyaya and A. Upadhyaya, Material Science and Engineering, Anshan Publications, 2007.

Suggested Reference Books

1. R. A. L Jones, Soft Condensed Matter, Oxford University Press, 2002.
2. William D. Callister, David G. Rethwisch Materials Science and Engineering: An Introduction, Wiley Publisher.
3. B. S. Mitchell An Introduction to Materials Engineering and Science for Chemical and Materials Engineers, John Wiley & Sons, 2004..

Course outcomes

At the end of this course, students will have a fair understanding of hard and soft materials, including polymers and composites, their characterization, properties, and use in engineering applications.-

PROFESSIONAL CORE COURSES



PCC-CS101	Material and Energy Balance Computations	3L:1T:0P	4 credits
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Objectives

The course will serve as a basis for all further chemical engineering courses that are part of the curriculum.

Contents :

1. Introductory concepts of units, physical quantities in chemical engineering, dimensionless groups, “basis” of calculations [3L + 1T]
2. Material Balance: Introduction, solving material balance problems without chemical reaction [6L+2T]
3. Material Balance: With chemical reaction, Concept of stoichiometry and mole balances, examples, including combustion [6L+2T]
4. Material Balances with recycle, bypass and purge [6L+2T]
5. Gases, Vapours and Liquids: Equations of state, Vapour pressure, Clausius-Clapeyron equation, Cox chart, Duhring’s plot, Raoult’s law,. (6L+2T)
6. Energy balance: open and closed system, heat capacity, calculation of enthalpy changes (6L+2T)
7. Energy balances with chemical reaction: Heat of reaction, Heat of combustion (6L+2T)
8. Crystallization, Dissolution. (3L+1T)
9. Humidity and Saturation, humid heat, humid volume, dew point, humidity chart and its use. (3L+1T)

Total 60 (L+T)

Suggested Text Books

1. Himmelblau, D. M., Riggs, J. B. “Basic Principles and Calculations in Chemical Engineering”, Eighth Ed., Pearson India Education Services, 2015.
2. Bhatt, B. I., Vora, S. M., “Stoichiometry”, Fourth Edition, Tata McGraw Hill Publishing Company Ltd, 2004.

Suggested References Books

1. Felder, R. M.; Rousseau, R. W., “Elementary Principles of Chemical Processes”, Third Edition, John Wiley & Sons, 2000
2. Hougen, O. A., Watson, K. M., Ragatz, R. A., “Chemical Process Principles, Part-I Material & Energy Balances”, Second Edition, CBS Publishers & Distributors, 2004
3. Venkataramani, V., Anantharaman, N., Begum, K. M. Meera Sheriffa, “Process Calculations”, Second Edition, Prentice Hall of India.
4. Sikdar, D. C., “Chemical Process Calculations”, Prentice Hall of India.



Course outcomes

Students completing the course will

- Develop mastery over process calculations relevant to chemical engineering processes
- Be able to handle elementary flow-sheeting, material and energy balance calculations without and with chemical reactions, and involving concepts like recycle, bypass and purge.
- Be familiar with equations of state and properties of gases and liquids, including phase transition

PCC-CS102	Transport Phenomena	3L:1T:0P	4 credits
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Objectives:

- This course will highlight coupling between three transport phenomena with applications in various disciplines in engineering and science, and will demonstrate to the students the common mathematical structure of transport problems.
- The course will deal with flow problems involving Newtonian and non-Newtonian fluids, solid-state heat conduction, forced and free convection, binary diffusion with or without chemical reaction.

Contents :

1. Introduction to Transport Phenomena, Formulation of transport problems from nature(3L + 1T)
2. Vector and Tensor Analysis: Basic concepts (6L + 2T)
3. Basics of momentum transport: Euler/Lagrangian viewpoint, laminar and turbulent flows, boundary layers, stress tensor (3L + 1T)
4. Shell momentum balances, equations of change, dimensional analysis, applications to isothermal flow of Newtonian & non-Newtonian fluids. (9L + 3T)
5. Basics of energy transport, conductive, convective and viscous dissipation energy fluxes. (3L + 1T)
6. Equations of change for non-isothermal systems, dimensional analysis, and applications to steady-state conduction and convection (9L + 3T)
7. Basics of mass transport, mechanisms, and mass and molar fluxes (3L + 1T)
8. Derivation of equation of continuity for a binary mixture and its application to convection-diffusion problems. (6L + 2T)
9. Unsteady-state momentum, heat and mass transport, formulation of basic equations and similarity transform method (3L + 1T)

Total 60 (L + T)



Suggested Text Books

1. R. B. Bird, W. E. Stewart, and E. S. Lightfoot. Transport Phenomena, 2nd ed., Wiley India Pvt. Ltd., 2002.
2. Welty, C. E. Wicks, R. E. Wilson, and G. L. Rorrer. Fundamentals of Momentum, Heat, and Mass Transfer. 5th ed., Wiley India Pvt. Ltd., 2007.

Suggested References Books

1. W. M. Deen, Analysis of Transport Phenomena, Oxford University Press, 1998.
2. W. J. Thompson, Introduction to Transport Phenomena, Prentice Hall, 2000.

Course Outcomes

On completion of the course, students would be familiar with

- Basics of vector and tensor analysis
- Be able to solve transport problems using shell balances
- Formulate and solve one-dimensional transport problems by using the conservation equations
- Formulate simple multi-dimensional transport problems

PCC-CS103	Thermodynamics-II	3L:1T:0P	4 credits
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Pre-requisites: Thermodynamics-I

Objectives:

To introduce the concepts of fugacity, activity coefficient, vapour-liquid equilibrium and reaction equilibrium. Introduction to molecular thermodynamics.

Contents

1. Review of first and second law of thermodynamics (2L+1T)
2. Vapor-liquid equilibrium: phase rule, simple models for VLE; VLE by modified Raoult's law; VLE from K-value correlations; Flash calculations. (6L+2T)
3. Solution Thermodynamics: fundamental property relationships, free energy and chemical potential, partial properties, definition of fugacity and fugacity coefficient of pure species and species in solution, the ideal solution and excess properties. (9L+3T)
4. Liquid phase properties from VLE, Models for excess Gibbs energy, heat effects and property change on mixing. (5L+2T)
5. UNIFAC and UNIQUAC models. (5L+2T)
6. Liquid-Liquid Equilibria; Vapor-Liquid-Liquid Equilibria; Solid-Liquid Equilibria; Solid-Gas Equilibria. (6L+2T)



7. Chemical reaction equilibria: equilibrium criterion, equilibrium constant, evaluation of equilibrium constant at different temperatures, equilibrium conversion of single reactions, multireaction equilibria. (6L+2T)

8. Introduction to molecular/statistical thermodynamics (6L+1T)

Total 60 (L+T)

Suggested Text Books

1. J.M. Smith, H.C. Van Ness and M.M. Abbott, "Introduction to Chemical Engineering Thermodynamics", 7th edition, McGraw-Hill International Edition, 2005.

Suggested References Books

1. S.Sandler, "Chemical, Biochemical and Engineering Thermodynamics", 4th edition, Wiley, India.
2. Y.V.C.Rao, "Chemical Engineering Thermodynamics", University Press, Hyderabad, 1997.

Other Resources and Study Material

At the end of the course, the student should be able to solve problems involving equilibria of different phases such as VLE, LLE, VLLE, SLE, SVE as well as reaction equilibria.

PCC-CS104	Heat Transfer	3L:1T:0P	4 credits
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Pre-requisites : Transport Phenomena

Objectives:

- Basic Concepts of Heat Transfer
- Design and Rating of Heat exchangers with and Without Phase Change
- Design and Rating of Compact Heat Exchangers

Contents :

1 Heat Transfer Fundamentals: Modes of heat transfer, thermal diffusivity and heat transfer coefficient; Differential equations of heat transfer; special forms (3L + 1T)

2. Conductive heat transfer - one dimensional problems, heat transfer from extended surfaces, two and three dimensional problems, Insulation (6L + 2T)

3. Convective heat transfer - natural and forced convection; Dimensional analysis; Thermal boundary layer; Analogies and Correlations (6L + 2T)

4. Design of heat transfer equipment - double pipe heat exchanger, concept of LMTD, DPHE sizing; shell and tube heat exchanger - Kern's method for design, effectiveness-NTU method, construction aspects in brief, Bell Delaware Method (9L + 3T)

5. Design aspects of finned tube and other compact heat exchangers (6L + 2T)



6. Basics of Heat transfer with phase change - Introduction to boiling, Introduction to condensation (3L + 1T)

7. Design aspects of Condensers, Reboilers and Evaporators (6L + 2T)

8. Heat Transfer to Agitated tanks, unsteady state heat transfer (3L + 1T)

9. Introduction to Radiative Heat Transfer, Design aspects of Furnaces (3L + 1T)

Total 60 (L + T)

Suggested Text Books

1. R. Welty, C. E. Wicks, R. E. Wilson, G. Rorrer, Fundamentals of Momentum, Heat and Mass Transfer, 4th Ed., Wiley (2007).
2. W. J. McCabe, J. Smith, P. Harriot, Unit Operations of Chemical Engineering, Sixth Edition, McGraw Hill (2005).
3. Holman, J. P., S. Bhattacharya, Heat Transfer, 10th Ed., Tata McGraw-Hill (2011).
4. D. Q. Kern, Process Heat Transfer, Tata-McGraw Hill (1997).

Suggested References Books

1. Bejan, A., A. D. Kraus, Heat Transfer Handbook, John Wiley (2003).

Course Outcomes

Students will be able to

- Identify and select type of shell and tube exchanger based on TEMA classification
 - Design double pipe heat exchanger, Shell and tube heat exchanger, finned tube and other compact heat exchangers
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PCC-CS105	Mass Transfer -I	3L:0T:0P	3 credits
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Pre-requisites: Transport Phenomena

Objectives:

Basic Concepts of Mass Transfer, Staged and Continuous Contact equipment design, gas absorption and distillation

Contents:

1. Constitutive laws of diffusion; unsteady state diffusion (3 contact hrs.)
- 2: Convective mass transfer, interphase mass transfer and mass transfer coefficients, mass transfer correlations (6 contact hrs.)
3. Mass transfer theories/models (3 contact hrs.)
4. Effect of chemical reaction on mass transfer (9 contact hrs.)
5. Equilibrium stages and transfer units: number and height of transfer units; stage efficiency. (6 contact hrs.)
6. Gas absorption plate and packed column design; reactive absorption (3 contact hrs.)
7. Batch distillation; continuous binary fractionation (9 contact hrs.)
- 8 Azeotropic distillation; use of steam (3 contact hrs.)
- 9 Introduction to multicomponent distillation (3 contact hrs.)

Total 45 lectures

Suggested Text Books

1. Binay K.Dutta, Principles of Mass Transfer and Separation Processes, 2nd edition, Prentice Hall of India, 2007
2. R.E. Treybal, Mass Transfer Operations, 3rd Edition, McGraw Hill, New Delhi, 1983.
3. E.D. Cussler, Diffusion - Mass Transfer in Fluid Systems, Cambridge University Press, Cambridge 1984.
4. S. Foust, Principles of Unit Operations, 2nd Edition, Wiley, New York, 1980.

Suggested References Books

1. C.J. Geankoplis, Transport Processes and Unit Operations, 3rd Edition, Prentice Hall, India, 1993.

Course Outcomes

Students will be

- Able to design staged and continuous contactors
- Familiar with special distillation techniques such as steam distillation and azeotropic distillation



PCC-CS106	Fluid Mechanics	3L:1T:0P	4 credits
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Pre-requisites: Transport Phenomena

Objectives:

- The objective of this course is to introduce the mechanics of fluids (fluid statics and fluid dynamics), relevant to Chemical Engineering operations.
- The course will introduce students to forces on fluids, hydrostatic forces on submerged bodies, Eulerian and Lagrangian descriptions of flow, flow visualization, integral analysis involving mass and momentum balances, Bernoulli equation, flow through pipes and ducts, flow measurement and instruments, flow transportation - pumps, blowers and compressors, conservation of mass, linear and angular momentum in differential form, Navier-Stokes equation, viscous flows, skin and form friction, lubrication approximation, potential flows and boundary layer theory. Turbulence and turbulent flows will be introduced.

Contents :

1 Introduction to fluids, Continuum hypothesis, Forces on fluids, Normal and shear stresses (3L + 1T)

2 Fluid statics - pressure distribution, Manometry, Forces on submerged bodies (planar and curved), Buoyancy, Rigid body motion (translation and rotation)(3L + 1T)

3 Kinematics of fluid flow- Eulerian and Lagrangian descriptions, Flow visualization, Stream function, Vorticity and Circulation, Kinematic decomposition of flow motion (3L + 1T)

4 System and control volume approaches, Reynolds transport theorem, Integral balances - mass and momentum, Euler's equation of motion, Bernoulli equation and applications, Turbulent flow, Head loss in pipe flow, Moody diagram (6L + 2T)

5: Flow measurement, Transportation of fluids - pumps, selection and design of pumps (3L + 1T)

6 Differential analysis: mass and momentum balances, Navier-Stokes equation, Unidirectional flow, Viscous flow, Stokes law, Skin drag and pressure drag (6L + 2T)

7 Potential flow, Potential function, Solution of Laplace equation (3L + 1T)

8 Boundary layer theory, Blasius solution, Boundary layer separation, Drag and lift force on immersed body. (6L + 2T)

9 Similitude analysis, Lubrication approximation (3L + 1T)

10 Compressible flows, Blowers and compressors (3L + 1T)

11 Introduction to turbulence: Structure of turbulence, visualization of turbulence, Reynolds decomposition, Spectral nature of turbulence and Kolmogorov hypothesis. (6L + 2T)

Total 60 (L+T)



Suggested Text Books

1. M. White, Fluid Mechanics, 8th Edition, Tata-McGraw Hill, 2016.
2. V. Gupta and S. K. Gupta, Fundamentals of Fluid Mechanics, 2nd Edition, New Age International 2011.
3. W. L. McCabe, J. C. Smith and P. Harriot, Unit Operations of Chemical Engineering, 7th Edition, McGraw-Hill International Edition 2005.
4. O. Wilkes, Fluid Mechanics for Chemical Engineers, Prentice Hall of India, 2005.
5. R. W. Fox, P. J. Pritchard and A. T. McDonald, Introduction to Fluid Mechanics, 7th Edition, Wiley-India 2010.
6. R. Welty, C. E. Wicks, R. E. Wilson, G. Rorrer, Fundamentals of Momentum, Heat and Mass Transfer, 4th Ed., Wiley (2007).

Suggested References Books

1. B.R. Munson, D.F. Young, T.H. Okiishi and W. W. Huebsch, 6th Edition, Wiley-India 2010.
2. R.L. Panton, Incompressible Flow, 3rd Edition, Wiley-India 2005.
3. R.B. Bird, W. E. Stewart and E. N. Lightfoot, Transport Phenomena, 2nd Edition, Wiley-India 2002.

Other Resources and Study Material

Students should be able to calculate

- Velocity profiles by simplification of equations of motion in simple 1-D flows
 - Boundary layer thicknesses, friction factor, pressure drop, power requirements in single phase flow in pipes
 - Two phase gas/liquid pressure drop
 - Power requirements, NPSH requirements of pumps
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PCC-CS107	Numerical Methods in Chemical Engineering	2L:0T:2P	3 credits
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Pre-requisites: Mathematics – I, Mathematics - II

Objectives:

To introduce students to numerical methods used to solve engineering problems, in particular chemical engineering problems, using numerical methods and computer programming. Fundamentals of numerical methods/algorithms to solve systems of different mathematical equations (e.g. linear/ non-linear algebraic equations, ordinary /partial differential equations), will be introduced. The course would enable students to write their own computer programs using programming languages like C and commercial software like Matlab. Hands-on experience will be provided to apply these computer programs to solve problems in different areas of chemical engineering e.g. fluid flow, heat and mass transfer, chemical reaction engineering etc. Practicals to involved solving actual chemical engineering problems through computer programming and coding.

Contents :

- 1.Introduction, Approximation and Concept of Error & Error Analysis(2lectures)
 - 2.Linear Algebraic Equations: Methods like Gauss elimination, LU decomposition and matrix inversion, Gauss-Siedel method, Chemical engineering problems involving solution of linear algebraic equations (4 lectures)
 - 3.Root finding methods for solution on non-linear algebraic equations: Bisection, Newton-Raphson and Secant methods, Chemical engineering problems involving solution of non-linear equations (3 lectures)
 - 4.Interpolation and Approximation, Newton's polynomials and Lagrange polynomials, spline interpolation, linear regression, polynomial regression, least square regression (4 lectures)
 - 5:Numerical integration: Trapezoidal rule, Simpson's rule, integration with unequal segments, quadrature methods, Chemical engineering problems involving numerical differentiation and integration (3 lectures)
 - 6.Ordinary Differential Equations: Euler method, Runge-Kutta method, Adaptive Runge-Kutta method, Initial and boundary value problems, Chemical engineering problems involving single, and a system of ODEs (10 lectures)
 - 7.Introduction to Partial Differential Equations: Characterization of PDEs, Laplace equation, Heat conduction/diffusion equations, explicit, implicit, Crank-Nicholson method (4 lectures)
- Total 30 lectures



Practical

Practical description [No. of turns (2 hrs)]

1. Introduction to use of computers for numerical calculations (1 practical turn)
2. Solution of linear algebraic equations using Gauss elimination, Gauss-Siedel etc. (2 practical turns)
3. Solution of a non-linear equations using bracketing and Newton-Raphson method (2 practical turns)
4. Interpolation and Approximation(2 practical turns)
5. Numerical integration(2 practical turns)
6. Euler method (1 practical turn)
7. Runge-Kutta methods for ODEs (2 practical turns)
8. Solution of system of ODEs using simple methods (1 practical turn)
9. Solution of simple PDEs (2 practical turns)

Total 15 practical turns

Suggested Text Books

1. Gupta, S. K., "Numerical Methods for Engineers, New Academic Science, 2012.

Suggested References Books

1. S.C. Chapra & R.P. Canale, "Numerical Methods for Engineers with Personal Computer Applications", McGraw Hill Book Company, 1985.
2. R.L. Burden & J. D. Faires, "Numerical Analysis", 7th Ed., Brooks Coles, 2000.
3. Atkinson, K. E., "An Introduction to Numerical Analysis", John Wiley & Sons, 1978.
4. Press, W. H. et al., "Numerical Recipes in C: The Art of Scientific Computing, 3rd Edition, Cambridge University Press, 2007.

Course Outcomes

Students will be able to solve chemical engineering problems involving

- Linear and non-linear equations
- Ordinary and partial differential equations using programming languages like C and softwares like MATLAB.

PCC-CS108	Chemical Reaction Engineering - I	3L:1T:0P	4 credits
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Pre-requisites :Material and Energy Balance Computations

Objectives

- Basic Concepts of Kinetics and Rate Laws
- Design and Rating of Ideal Reactors including heat effects
- Interpretation of Rate data
- Design and Rating of Reactors involving multiple reactions including heat effects
- Analysis of Non-ideal flow Behavior in Reactors



Contents :

- 1 Reactions and reaction rates - stoichiometry, extent of reactions, conversion, Selectivity
Reaction rate fundamentals - elementary reaction sequences, steady state approximation and rate limiting step theory (6L+2T)
- 2 Ideal reactors - generalized material balance, design equations, graphical interpretation (3L+1T)
- 3 Sizing and analysis of ideal batch, mixed (CSTR), plug flow and recycle reactors - solving design equations for constant and variable density systems, reactors in series and parallel (9L+3T)
- 4 Analysis and correlation of experimental kinetic data - data collection & plotting, linearization of rate equations, differential and integral method of analysis (6L+2T)
- 5 Multiple reactions - conversion, selectivity, yield, series, parallel, independent and mixed series-parallel reactions (6L+2T)
- 6 Multiple reactions - conversion, selectivity, yield, series, parallel, independent and mixed series-parallel reactions (6L+2T)
- 7 RTD theory and analysis of non-ideal reactors (9L+3T)

Total : 60 (L+T)

Suggested Text Books

- 1 Elements of Chemical Reaction Engineering by H. Scott Fogler, 2nd Edition, Prentice Hall 2001

Suggested References Books

- 1 Chemical Reaction Engineering by Octave Levenspiel, 3rd Edition, John Wiley & Sons 2001

Course outcomes

Students will be able to

- Design chemical reactors involving heat effects optimally using minimum amount of data
 - Fix some problems related to operability and productivity
 - Operate reactors in a safe manner for single and multiple reactions
 - Analyse the non-ideality in the reactors
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PCC-CS109	Mass Transfer –II	3L:0T:0P	3 credits
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Pre-requisites: Mass Transfer – I

Objectives

Unit Operations based on Mass Transfer

Contents:

- 1 Perspective on unified approach to operations (2 contact hrs.)
 - 2: Liquid-liquid Extraction (6 contact hrs.)
 - 3 Leaching & Washing (3 contact hrs.)
 - 4 Adsorption, Ion-Exchange; Fixed bed absorbers, breakthrough (10 contact hrs)
 - 5 Simultaneous Heat & Mass Transfer: Humidification and Dehumidification (3 contact hrs.)
 - 6 Simultaneous Heat and Mass Transfer: Drying (3 contact hrs.)
 - 7 Design of Cooling Towers (6 contact hrs)
 - 8 Membrane processes (6 contact hrs)
 - 9 Ultrafiltration and Osmosis, Reverse Osmosis (6 contact hrs)
- Total 45 lectures

Suggested Text Books

1. Binay K.Dutta, Principles of Mass Transfer and Separation Processes, 2nd edition, Prentice Hall of India, 2007
2. R.E.Treybal, Mass Transfer Operations, 3rd Edition, McGraw Hill, New Delhi, 1983.
3. AS. Foust, Principles of Unit Operations, 2nd Edition, Wiley, New York, 1980.
4. W.L. McCabe, J. Smith and P. Harriot, Unit Operations of Chemical Engineering, 7th Edition, Tata McGraw Hill, India, 2014.

Suggested References Books

1. C.J. Geankoplis, Transport Processes and Unit Operations, 3rd Edition, Prentice Hall, India, 1993.

Course Outcomes

Students will be able to

- List situations where liquid–liquid extraction might be preferred to distillation
 - Explain the concept of breakthrough in fixed-bed adsorption
 - Design cooling towers
 - Distinguish among micro-filtration, ultra-filtration, nano-filtration, and reverse osmosis
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PCC-CS110	Chemical Engineering Lab - I	0L:0T:4P	2 credits
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Pre-requisites : Fluid Mechanics, Heat Transfer, Mass Transfer - I

Objectives:

Chemical Engineering lab provides students the first hand experience of verifying various theoretical concepts learnt in theory courses. It also serves as a bridge between theory and practice. This particular lab focuses on fluid dynamics, heat and mass transfer

Contents :

1. 4 – 5 experiments on fluid flow such as: flow through pipes and fittings, flow through coil, flow through fittings, packed and fluidized beds, orifice and venturimeter, non-Newtonian flow in pipes, characteristics of pumps, sedimentation and filtration (16 lab. Hours)

2. 4 – 5 experiments on heat transfer such as: double pipe, shell and tube exchangers, natural convection, fin efficiency, thermal conductivity and specific heat (16 lab. Hours)

3. 2 – 3 experiments on mass transfer such as: diffusivity in gases and liquids, absorption in packed column, (8 lab. Hours)

4. 2 – 3 experiments on Thermodynamics such as: Refrigeration cycle, vapor – liquid and liquid – liquid equilibria, partial molar properties (8 lab. Hours)

Total 48 lab. Hours

Lab. Outcomes

Students will be able to

- Learn how to experimentally verify various theoretical principles
- Visualize practical implementation of chemical engineering equipment
- Develop experimental skills

PCC-CS111	Particle and Fluid-Particle Processing	3L:0T:0P	3 credits
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Pre-requisites : Fluid Mechanics

Objectives

Objective of this course is to introduce students to the numerous industrial operations dealing with the particulate solids, their handling in various unit operations, and those in which particle-fluid interactions are important. The course addresses fundamentals of fluid-particle mechanics, such as the notion of drag, and builds on those fundamentals to develop design concepts for various industrial processes like packed bed operation, fluidized operations, sedimentation, filtration, separation of solids and fluids, etc. Industrial applications are discussed. The course is concluded



with an introduction to colloidal systems, soft materials and nanoparticles. Applications of these novel systems are discussed.

Contents :

1Introduction: Relevance of fluid and particle mechanics, and mechanical operations, in chemical engineering processes (1 lecture)

2: Solid particle characterization: Particle size, shape and their distribution; Relationship among shape factors and particle dimensions; Specific surface area; Measurement of surface area (5 lectures)

3 Flow around immersed bodies: Concept of drag, boundary layer separation, skin and form drag, drag correlations (4 lectures)

4Packed bed: Void fraction, superficial velocity, channeling, Ergun equation and its derivation, Kozeny Carman equation, Darcy's law and permeability, Blaine's apparatus (4 lectures)

5Fluidization: Fluidized bed, minimum fluidization velocity, pressure drop, Geldart plot etc. Types of fluidization: Particulate fluidization, Bubbling fluidization, Classical models of fluidization, Circulating fluidized beds, Applications of fluidization (5 lectures)

6 Separation of solids from fluids: Introduction (1 lecture)

7 Sedimentation: Free Settling, hindered settling, Richardson-Zaki equation, design of settling tanks (3 lectures)

8Filtration: Concepts, design of bag filters, design of electrostatic filters (3 lectures)

9Centrifugal separation, design of cyclones and hydrocyclones(3 lectures)

10Size reduction, milling, laws of comminution, classification of particles (3 lectures)

11 Size enlargement; Nucleation and growth of particles (3 lectures)

12 Transport of fluid-solid systems: pneumatic and hydraulic conveying (2 lectures)

13 Colloidal particles: stabilization, flocculation (3 lectures)

14Introduction to nanoparticles: Properties, characterization, synthesis methods, applications (5 lectures)

Total 45 lectures



Suggested Text Books

1. McCabe, W., Smith, J. and Harriott, P. Unit Operations of Chemical Engineering, 6th edition., McGraw Hill.
2. Coulson and Richardson's Chemical Engineering, Vol. 2, Butterworth-Heinemann, Fifth edition 2002.

Suggested References Books

1. Rhodes, M. J., Introduction to Particle Technology, 2nd edition, John Wiley, Chichester ; New York, 2008.
2. Allen, T., Powder Sampling and Particle Size Determination, Elsevier, 2003.
3. Masuda, H., Higashitani, K., Yoshida, H., Powder Technology Handbook, CRC, Taylor and Francis, 2006.
4. Vollath, D. Nanomaterials: An Introduction to Synthesis, Properties and Applications, 2nd Ed., Wiley, 2013.

Course Outcomes

Students will be able to

- Calculate drag force and terminal settling velocity for single particles
- Calculate pressure drop in fixed and fluidized beds
- Know the significance and usage of different particulate characterization parameters, and equipment to estimate them
- Describe Size reduction energy requirements, estimate performance of equipment, selection and sizing of equipment.
- Analyse filtration data and select systems based on requirements, estimate filtration area for given requirements, understand filter aids and their usage

PCC-CS112	Chemical Reaction Engineering – II	3L:0T:0P	3 credits
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Pre-requisites : Chemical Reaction Engineering – I

Objectives

- Basic Concepts of Catalysis
- Kinetics and Mechanistic aspects of Catalysts
- Design and Rating of Catalytic Reactors
- Design Aspects of Gas-Liquid Reactors

Contents:

1. Introduction to Catalysis, homogeneous and heterogeneous catalysis. Preparation and characterisation of catalysts (3 lectures)



2. Physical and chemical adsorption, Adsorption isotherms, Determination of BET surface area and pore volume of the Catalyst (3 lectures)
3. Kinetics of solid catalyzed gas phase reaction (6 lectures)
4. Laboratory reactors for catalytic gas solid reactions. Design concepts (3 lectures)
5. Mass transfer, Diffusion and Chemical reactions in catalysts. Effects of external mass transfer and heat transfer, Effectiveness factor. Design aspects of catalytic reactors. (12 lectures)
6. Non-catalytic gas-solid reactions, different model for gas-solid reactions (6 lectures)
7. Gas liquid reactions, film and penetration theories, enhancement factor in gas-liquid reactions, gas-liquid reactors (12 lectures)

Total 45 lectures

Suggested Text Books

1. Elements of Chemical Reaction Engineering, Foggler H. S., Prentice Hall, 2001

Suggested References Books

1. Chemical and Catalytic Reaction Engineering, Carberry, J. J., Dover Books on Chemistry, 2001.
2. Chemical Reactor Analysis and Design Gilbert F. Froment, Kenneth B. Bischoff, Juray De Wilde, John Wiley & Sons, Incorporated, 2010

Course Outcomes

Students will be able to

- Design catalytic reactors
 - Identify regions of mass transfer control and reaction rate control and calculate conversion
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PCC-CS113	Process Technology and Economics	3L:0T:0P	3 credits
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Pre-requisites : Fluid Mechanics, Mass Transfer-I, Chemical Reaction Engineering – I

Objectives:

To familiarize students with manufacturing aspects of industrially relevant chemicals

Contents :

1 Description, raw material and energy sources and consumptions, operating conditions, catalysts, basic block diagram and simplified process flow diagram for manufacture of inorganic chemicals, such as: inorganic acids, chlor-alkali, ammonia, fertilizers, etc. (9 lectures)

2: Description, raw material and energy sources and consumptions, operating conditions, catalysts, basic block diagram and simplified process flow diagram for Petroleum refining and cracking operations, syngas and hydrogen, (9 lectures)

3 Description, raw material and energy sources and consumptions, operating conditions, catalysts, basic block diagram and simplified process flow diagram for manufacture of Petrochemicals: C1, C2, C3, C4, etc., benzene, toluene, xylene and other petrochemicals from these basic building blocks (18 lectures)

4 Industrially relevant fuels, coal, coal based chemicals and fuels
Common utilities such as electricity, cooling water, steam, hot oil, refrigeration and chilled water

5 Introduction to project cost and cost of production, Various components of cost of production and their estimation, Various components of project cost and their estimation.
Estimation of working capital. (6 lectures)

6 Analysis of working results project: Balance sheets, Project financing, concept of interest, time value of money, depreciation. Profitability Analysis of Projects (3 lectures)
Total 45 lectures

Suggested Text Books

1. Shreve's Chemical Process Industries, George T. Austin, McGraw-Hill International Editions Series, 1984
2. Dryden's Outlines of Chemical Technology, M. Gopala Rao, Marshall Sittig, East West Press, 1997
3. Chemical Project Economics, Mahajani V. V. and Mokashi S M., MacMillan India Ltd. 2005
4. Plant Design and Economics for Chemical Engineers, Max Peters, Klaus Timmerhaus, Ronald West, McGraw Hill International Edition, 2013

Suggested References Books

1. Chemical Process Technology, Moulijn, M. and van Dippen, Wiley, 2013



Course outcomes

Students will be able to

- Describe sources and processes of manufacture of various industrially important chemicals
- Draw block diagrams/ process flow diagrams of the processes used for manufacture of industrially important chemicals
- Explain and calculate economic aspects of Projects involved in manufacturing of Chemicals

PCC-CS114	Process Control	3L:0T:0P	3 credits
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Pre-requisites : Material and Energy Balance Calculations, Chemical Reaction Engineering – I

Objectives

Objective is to introduce the fundamentals of process control with applications using P, PI, and PID controllers. The course will teach the students about mathematical models based on transfer function approach for single loop systems, how to obtain dynamic response of open loop and closed loop systems, stability analysis in transient and frequency domains, and controller tuning methods. The course would end with more advanced concepts like feed-forward control, ratio control, model-predictive control, ratio control, dead-time compensation, etc.

Contents :

1Introductory Concepts: Need for control and automation, control logic, servo and regulatory control, block diagrams, control structures (feedback vs. feedforward), process and instrumentation diagrams (3 lectures)

2 Laplace transforms, solution of ODEs using Laplace transform (4 lectures)

3 Transfer function approach, response of first order systems: step, impulse and sinusoidal response, first order systems in series (5 lectures)

4Second order systems, higher order systems, transportation lag and dead time (4 lectures)

5Linear closed loop systems, development of block diagrams, classical feedback controllers. (4 lectures)

6Final control element (control valves), block diagram reduction techniques (3 lectures)

7 Closed loop response, servo and regulatory problems (2 lectures)

8Stability analysis, Routh stability criterion, Root locus diagrams (rule based) (3 lectures)

9Introduction to frequency response, notion of stability (4 lectures)

10Bode diagrams, Nyquist plots, Bode and Nyquist stability criterion (5 lectures)



11 Controller tuning: Ziegler-Nichols method, Cohen-Coon method (3 lectures)

12 Introduction to advanced controllers: cascade control, feed forward control, ratio control, Smith-predictor, IMC, MPC, dead-time compensation (3 lectures)

13 Introduction to digital control (2 lectures)

Total 45 lectures

Suggested Text Books

1. Coughanowr, D. R., LeBlanc, S. “Process Systems Analysis and Control”, 3rd edition, McGraw-Hill (2008).

Suggested References Books

1. Seborg, D.E., Edgar, T.F., Mellichamp, D.A. “Process Dynamics and Control”, 2nd edition, John Wiley (2003)
2. Stephanopoulos, G. “Chemical Process Control: An Introduction to Theory and Practice”, Pearson Education (1984)

Course Outcomes

Students will be able to

- Understand the importance of process dynamics (unsteady state operation)
- Tune a controller to reject disturbances or manage operating point transitions

PCC-CS115	Chemical Engineering Lab - II	0L:0T:4P	2 credits
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Pre-requisites :Chemical Reaction Engineering I, Mass Transfer - II

Objectives

Chemical Engineering lab provides students the first-hand experience of verifying various theoretical concepts learnt in theory courses. It also serves as a bridge between theory and practice. This particular lab focuses on fluid dynamics, heat and mass transfer

Contents :

i)6– 7experiments on Chemical Reaction Engineering such as: residence time distribution, axial dispersion in columns, pipes and stirred tanks, plug flow and CSTR, kinetics of reactions such as dehydration of butanol, condensation polymerization, esterification and hydrolysis, degradation of dyes using photocatalysts etc. (24 lab. hrs)



ii) 6 – 7 experiments on Mass Transfer such as: batch and steam distillation, packed and plate distillation columns, adsorption and ion exchange, liquid – liquid extraction columns, drying (24 lab. hrs)

Total 48 lab. Hrs

Course Outcomes

Students will be able to

- Learn how to experimentally verify various theoretical principles
- Develop experimental skills
- Visualize practical implementation of chemical engineering equipment

PCC-CS116	Design & Simulation Lab	1L:0T:4P	3 credits
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Pre-requisites : Numerical Methods, Material and Energy Balance

Objectives

To introduce students to use of software packages such as ASPEN, MATLAB, FLUENT for simulation, and also analysing flowsheets

Contents :

1Introduction to Software Packages (3 lectures)

2Setting up models for simulation (3 lectures)

3Steady State simulation using ASPEN, Flowsheeting concepts (sequential modular, equation oriented) (3 lectures)

4Dynamic simulation using MATLAB (3 lectures)

5CFD simulations using FLUENT, geometry & meshing (3 lectures)

Total 15 lectures

Practical

Practicals Description (examples may be drawn from Fluid Flow, Heat Transfer, Reaction Engineering, Process Control) [No. of turns 3-4 hrs.]

- ASPEN based calculations (3 practical turns)
- Dynamic simulations using MATLAB(3 practical turns)
- CFD computations using FLUENT(3 practical turns)
- Make up slots/Exam slots(3 practical turns)

Total 60(P)



Suggested Text Books

As per manuals/literature supplied by Software Vendor

Outcomes

Students will be able to

- Solve chemical engineering problems using advanced programming softwares
- Use simulation softwares like ASPEN and FLUENT
- Analyse the techno-economic feasibility of chemical manufacturing facility

PCC-CS117	Instrumentation & Control Lab	1L:0T:4P	3 credits
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Pre-requisites : Process Control

Objectives

Objective of the course is to introduce the basics of instrumentation and process control through a hands-on practical experience. Principles of operation of different measuring devices for temperature, level, pressure, flow, pH, humidity, density, and viscosity will be introduced to impart knowledge of transmitters, transducers, converters, control valves, digital and analog components related to PLC, DCS, SCADA systems.

Contents:

1 Basics of control system components, signals and standards (2 contact hrs.)

2 Pressure measuring instruments/sensors (1 contact hr.)

3 Level measurement (1 contact hr)

4 Flow measuring instruments (1 contact hr.)

5 Temperature measuring devices (1 contact hr)

6 Humidity, density, viscosity and pH measuring devices (2 contact hrs.)

7 Pressure controllers: regulators, safety valves (1 contact hr)

8 Flow control actuators: different types of valves (1 contact hr.)

9 Electrical and pneumatic signal conditioning and transmission (1 contact hr)

10 Computer process control, PLC, DCS, SCADA (4 contact hrs.)

Total 15 lectures



Laboratory Modules

Experiment Description [Number of turns (3-4 hours)]

- 1 Control valves (1 turn)
 - 2 Temperature and pressure measuring devices (2 turns)
 - 3 Level and flow measuring devices (2 turns)
 - 4 Viscosity and pH measuring devices (2 turns)
 - 5 Transmitters and transducers (1 turn)
 - 6 Open loop systems: lagged thermometer, stirred-tank heater (2 turns)
 - 7 Temperature, level, and pressure control trainers (3 turns)
 - 8 Flow-level cascade control (2 turns)
- Total 60(P)

Suggested Text Books

1. William C. Dunn, Fundamentals of Industrial Instrumentation and Process Control, McGraw-Hill (2005).
2. S.K. Singh, Industrial Instrumentation and Control, 3rd edition, McGraw-Hill (2008).

Suggested References Books

1. Seborg, D.E., Edgar, T.F., Mellichamp, D.A. "Process Dynamics and Control", 2nd edition, John Wiley (2003).
2. Stephanopoulos, G. "Chemical Process Control: An Introduction to Theory and Practice", Pearson Education (1984).

Outcomes

Students will be well-familiar with instrumentation and automation as relevant to modern chemical plant operation.

PROFESSIONAL CORE ELECTIVES



PEC-CSEL	Water Conservation and Management	3L:0T:0P	3 credits
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Contents (45 lectures)

Introduction: water cycle, water storage, water quality; water conservation in homes; water conservation in the work place; water management-water quality, controlling use and quality of water, water flow measurement, water quality control, testing water salinity, preserving water quality, minimising evaporation, water sanitation, water audits; water conservation in agriculture; water conservation in process industry; water conservation in construction industry; water conservation in service industry.

PEC-CSEL	Sustainability Engineering	3L:0T:0P	3 credits
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Contents (45 lectures)

Introduction to the idea of sustainability and its relevance; environment-related legislation; air and water pollution; solid waste management; local and global environmental challenges; climate change; tools used to ensure sustainability in engineering activities (environmental management systems and environmental impact assessment); green buildings; green chemistry; sustainable cities; sustainable transportation; sustainable sources of energy; economic and social factors affecting sustainability.

PEC-CSEL	Interfacial Engineering	3L:0T:0P	3 credits
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Contents (45 lectures)

Introduction; capillary phenomena; amphiphilic systems-surface activity, micellization, microemulsions; colloid interactions and flocculation; rheology of dispersions; emulsification; adsorption and film formation; flotation.

PEC-CSEL	Nanoscience and Nanotechnology	3L:0T:0P	3 credits
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Contents (45 lectures)

Introduction; surface effects and physical properties of nanomaterials; electrical, magnetic and optical properties; nanoscale measurement and characterization; design and synthesis of nanomaterials; nanoscale devices for various applications (photovoltaics, medical diagnostics, electronics).

PEC-CSEL	Advanced Separation Processes	3L:0T:0P	3 credits
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Contents (45 lectures)

Fundamentals; membrane based separation processes; external field induced membrane separation processes for colloidal particles; gas separation; surfactant based separation processes; centrifugal separation processes ; ion exchange and chromatographic separation processes; supercritical fluid extraction.



PEC-CSEL	Polymer Science and Engineering	3L:0T:0P	3 credits
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Contents (45 lectures)

Basic concepts; polymerization mechanism and synthesis; copolymerization; polymerization techniques; polymer characterization; polymer rheology; polymer processing; properties of some commercial polymers.

PEC-CSEL	Environmental Pollution and Control	3L:0T:0P	3 credits
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Contents (45 lectures)

Introduction (types of pollution, water standards for potable and agricultural streams, air standards); Air pollution - air pollutants and interaction products, preventive and control measures; Water pollution-waste water sampling and analysis, primary, secondary and tertiary treatment methods; Solid waste management- collection, storage and transport, processing and transformation, incineration, composting and sanitary landfilling; Pollution control in chemical process industry.

PEC-CSEL	Renewable Energy	3L:0T:0P	3 credits
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Contents (45 lectures)

Introduction (world energy status, current energy scenario in India, environmental aspects of energy utilization, energy and sustainable development; Solar energy (basic concepts, flat plate and concentrating collectors, solar desalination, solar pumping, solar photo voltaic conversion, solar cells); Wind energy (availability, wind power plants, wind energy conversion systems, site characteristics, types of wind turbines); energy from biomass(biomass resources, biomass conversion technologies - direct combustion, pyrolysis, gasification, anaerobic digestion, bioethanol and biodiesel production); Other Renewable Sources(Tidal energy; geothermal energy; hydroelectric).

PEC-CSEL	Optimization Methods	3L:0T:0P	3 credits
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Contents (45 lectures)

Introduction- problem statement, classification, optimization techniques; Classical optimization- single variable, multivariable with equality and inequality constraints; Nonlinear programming- direct and indirect search methods; Unconstrained optimization techniques; Constrained optimization techniques; Dynamic programming; Introduction to genetic algorithm.



MODEL CURRICULUM

AICTE Model Curriculum for Undergraduate degree in Chemical Engineering (Engineering & Technology)

for

UNDERGRADUATE DEGREE COURSES IN METALLURGICAL ENGINEERING AND MATERIALS SCIENCE

(Engineering & Technology)

[January 2018]



ALL INDIA COUNCIL FOR TECHNICAL EDUCATION
Nelson Mandela Marg, Vasant Kunj, New Delhi 110 070
www.aicte-india.org



**All India Council for Technical Education
Model curriculum for
Undergraduate Degree Courses in Engineering & Technology**

METALLURGICAL ENGINEERING AND MATERIALS SCIENCE

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All India Council for Technical Education
Model curriculum for
Undergraduate Degree Courses in Engineering & Technology
METALLURGICAL ENGINEERING AND MATERIALS SCIENCE

Chapter -1
General, Course structure & Theme
&
Semester-wise credit distribution

A. Definition of Credit:

1 Hr. Lecture (L) per week	1 credit
1 Hr. Tutorial (T) per week	1 credit
1 Hr. Practical (P) per week	1.5 credits
2 Hours Practical(Lab)/week	1 credit

B. Range of credits - A range of credits from 150 to 160 for a student to be eligible to get Under Graduate degree in Engineering. A student will be eligible to get Under Graduate degree with Honours or additional Minor Engineering, if he/she completes an additional 20 credits. These could be acquired through MOOCs.

C. Structure of Undergraduate Engineering program:

S. No.	Category	Suggested Breakup of Credits(Total 161)
1	Humanities and Social Sciences including Management courses	12*
2	Basic Science courses	25*
3	Engineering Science courses including workshop, drawing, basics of electrical/mechanical/computer etc	24*
4	Professional core courses	48*
5	Professional Elective courses relevant to chosen specialization/branch	18*
6	Open subjects – Electives from other technical and /or emerging subjects	18*
7	Project work, seminar and internship in industry or elsewhere	15*
8	Mandatory Courses [Environmental Sciences, Induction Program, Indian Constitution, Essence of Indian Knowledge Tradition]	(non-credit)
	Total	160*

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



D. Credit distribution in the First year of Undergraduate Engineering program :

	Lecture	Tutorial	Laboratory/Practical	Total credits
Chemistry –I	3	1	3	5.5
Physics	3	1	3	5.5
Maths-1	3	1	0	4
Maths -2	3	1	0	4
Programing for Problem solving	3	0	4	5
English	2	0	2	3
Engineering Graphics	1	0	4	3
Workshop/Practicals	1	0	4	3
Basic Electrical Engg.	3	1	2	5
*Biology	2	1	0	3
*Engg. Mechanics	3	1	0	4
*Maths-3	3	1	0	4

**These courses may be offered preferably in the 3rd semester & onwards.*

E. Course code and definition:

Course code	Definitions
BSC	Basic Science Courses
ESC	Engineering Science Courses
HSMC	Humanities and Social Sciences including Management courses
PCC	Professional core courses
PEC	Professional Elective courses
OEC	Open Elective courses
LC	Laboratory course
MC	Mandatory courses
PROJ	Project

BASIC SCIENCE COURSES

Sl. No	Code No.	Subject	Semester	Credits
1	BSC101	Physics 1 (Introduction to Mechanics)	1	5.5
2	BSC103	Mathematics-I (Calculus and Linear Algebra)	1	4
3	BSC102	Chemistry-I	2	5.5
4	BSC104	Mathematics-II (Calculus, ODE, Complex Variables)	2	4
5	BSC201	Biology	3	3
6	BSC203	Mathematics-III (Probability and Statistics)	3	4
			Total Credits:	26

**ENGINEERING SCIENCE COURSES**

Sl. No	Code No.	Subject	Semester	Credits
1	ESC101	Basic Electrical Engineering	1	5
2	ESC103	Engineering Graphics & Design	1	3
3	ESC102	Programming for Problem Solving	2	5
4	ESC104	Workshop/Manufacturing Practices	2	3
5	ESC201	Engineering Mechanics	3	4
6	ESC401	Introduction to Instrumentation	7	4
Total Credits:				24

HUMANITIES & SOCIAL SCIENCES INCLUDING MANAGEMENT

Sl. No	Code No.	Subject	Semester	Credits
1	HSMC102	English	2	3
2	HSMC202	Economics for Engineers	4	3
3	HSMC302	Introduction to Industrial Management	6	3
4	HSMC402	Fundamentals of Management for Engineers	8	3
Total Credits:				12

PROFESSIONAL CORE COURSES (PCC) METALLURGICAL ENGINEERING AND MATERIALS SCIENCE

Sl. No	Code No.	Subject	Semester	Credits
1	PCC-MM201	Introduction to Materials Engineering	3	2
2	PCC-MM203	Phase Transformations	3	3
3	PCC-MM205	Materials Thermodynamics	3	3
4	PCC-MM207	Metallography Laboratory	3	1
5	PCC-MM202	Mechanical Properties of Materials	4	3
6	PCC-MM204	Introduction to Transport Phenomena	4	3
7	PCC-MM206	Physical Metallurgy	4	3
8	PCC-MM208	Physics of Materials	4	3
9	PCC-MM210	Mechanical Metallurgy Laboratory	4	1
10	PCC-MM301	Materials Characterization	5	4
11	PCC-MM303	Environmental Degradation of Materials	5	3
12	PCC-MM305	Non Ferrous Extractive Metallurgy	5	4
13	PCC-MM307	Non-Metallic Materials	5	3
14	PCC-MM309	Materials Chemistry Laboratory	5	1
15	PCC-MM311	Characterization Laboratory	5	1
16	PCC-MM302	Iron Making and Steel Making Technology	6	4
17	PCC-MM304	Materials Processing	6	3
18	PCC-MM306	Processing Laboratory	6	1
19	PCC-MM308	Modelling and Simulations Laboratory	6	1
Total Credits:				47



**PROFESSIONAL ELECTIVE COURSES (PEC)
METALLURGICAL ENGINEERING AND MATERIALS SCIENCE**

[Any 6 from this basket of 12 courses]

Sl. No	Code No.	Subject	Semester	Credits
1	PEC-MM	Nanomaterials		3
2	PEC-MM	Functional Materials		3
3	PEC-MM	Energy Materials		3
4	PEC-MM	Biomaterials		3
5	PEC-MM	Electronic Materials		3
6	PEC-MM	Composite Materials		3
7	PEC-MM	Fatigue and Fracture Mechanics		3
8	PEC-MM	Failure Analysis		3
9	PEC-MM	Computational Materials Engineering		3
10	PEC-MM	Surface Engineering		3
11	PEC-MM	Foundry Technology		3
12	PEC-MM	Powder Metallurgy		3
Total Credits: 6 courses X 3 Credits each				18

**OPEN ELECTIVE COURSES (OEC)
METALLURGICAL ENGINEERING AND MATERIALS SCIENCE**

Sl. No	Code No.	Subject	Semester	Credits
1	OEC202	Open Elective-I	4	3
2	OEC204	Open-Elective-II	4	3
3	OEC302	Open-Elective-III	6	3
4	OEC401	Open-Elective-IV	7	3
5	OEC403	Open-Elective-V	7	3
6	OEC405	Open-Elective-VI	7	3
Total Credits:				18



4 year Curriculum structure
Undergraduate Degree in Engineering & Technology

Branch / course: Metallurgical Engineering and Materials Science

Total credits (4 year course) 160

I. **Mandatory 3-week Student Induction Program** (Please refer **Appendix-A** for guidelines details.)

II. Semester-wise structure of curriculum

[L= Lecture, T = Tutorials, P = Practicals & C = Credits]

Semester I (First year]

Branch/Course Metallurgical Engineering and Materials Science

Sl. No.	Category	Course Code	Course Title	Hours per week			Total contact hours	Credits
				Lecture	Tutorial	Practical		
1	Basic Science course	BSC101	Physics (Introduction to Mechanics)	3	1	3	7	5.5
2	Basic Science course	BSC103	Mathematics – I (Calculus and Linear Algebra)	3	1	0	4	4
3	Engineering Science Courses	ESC101	Basic Electrical Engineering	3	1	2	6	5
4	Engineering Science Courses	ESC103	Engineering Graphics & Design	1	0	4	5	3
							Total credits	17.5



Semester II (First year]

Branch/Course: Metallurgical Engineering and Materials Science

Sl. No.	Category	Code	Course Title	Hours per week			Total contact hours	Credits
				Lecture	Tutorial	Practical		
1	Basic Science courses	BSC102	Chemistry-I	3	1	3	7	5.5
2	Basic Science courses	BSC104	Mathematics – II (Calculus, ODE, Complex Variables)	3	1	0	4	4
3	Engineering Science Courses	ESC102	Programming for Problem Solving	3	0	4	7	5
4	Engineering Science Courses	ESC104	Workshop Manufacturing Practices	1	0	4	5	3
5	Humanities and Social Sciences including Management courses	HSMC102	English	2	0	2	4	3
							Total credits	20.5

Semester III (Second year] Curriculum

Branch/Course Metallurgical Engineering and Materials Science

Sl. No.	Category	Code	Course Title	Hours per week			Total contact hours	Credits
				Lecture	Tutorial	Practical		
1	Basic Science course	BSC201	Biology	2	1	0	3	3
2	Basic Science Course	BSC203	Mathematics III (Probability and Statistics)	3	1	0	4	4
3	Professional Core Course	PCC-MM201	Introduction to Materials Engineering	1	0	2	3	2
4	Professional Core Course	PCC-MM203	Phase Transformations	3	0	0	3	3



Sl. No.	Category	Code	Course Title	Hours per week			Total contact hours	Credits
5	Professional Core Course	PCC-MM205	Materials Thermodynamics	3	0	0	3	3
6	Professional Core Course	PCC-MM207	Metallography Laboratory	0	0	2	1	1
7	Engineering Science Course	ESC201	Engineering Mechanics	3	1	0	4	4
8	Mandatory course	MC	Environmental Sciences	-	-	-		0
Total credits							20	

Semester IV (Second year] Curriculum
Branch/Course Metallurgical Engineering and Materials Science

Sl. No.	Category	Code	Course Title	Hours per week			Total contact hours	Credits
				Lecture	Tutorial	Practical		
1	Professional Core Course	PCC-MM202	Mechanical Properties of Materials	3	0	0	3	3
2	Professional Core Course	PCC-MM204	Introduction to Transport Phenomena	3	0	0	3	3
3	Professional Core Course	PCC-MM206	Physical Metallurgy	3	0	0	3	3
4	Professional Core Course	PCC-MM208	Physics of Materials	3	0	0	3	3
5	Professional Core Course	PCC-MM210	Mechanical Metallurgy Laboratory	0	0	2	2	1
6	Humanities	HSMC 202	Economics for Engineers	3	0	0	3	3
7	Open Elective Course	OEC202						3
8	Open Elective Course	OEC204						3
Total credits							22	



Semester V (Third year] Curriculum
Branch/Course Metallurgical Engineering and Materials Science

Sl. No	Category	Code	Course Title	Hours per week			Total contact hours	Credits
				Lecture	Tutorial	Practical		
1	Professional Core Course	PCC-MM301	Materials Characterization	4	0	0	4	4
2	Professional Core Course	PCC-MM303	Environmental Degradation of Materials	3	0	0	3	3
3	Professional Core Course	PCC-MM305	Non Ferrous Extractive Metallurgy	4	0	0	4	4
4	Professional Core Course	PCC-MM307	Non-Metallic Materials	3	0	0	3	3
5	Professional Elective Course	PEC-MM301	Elective 1	3	0	0	3	3
6	Professional Elective Course	PEC-MM303	Elective 2	3	0	0	3	3
7	Professional Core Course	PCC-MM309	Materials Chemistry Laboratory	0	0	2	2	1
8	Professional Core Course	PCC-MM311	Characterization Laboratory	0	0	2	2	1
							Total credits	22

Semester VI (Third Year] Curriculum
Branch/Course Metallurgical Engineering and Materials Science

Sl. No.	Category	Code	Course Title	Hours per week			Total Contact Hours	Credits
				Lecture	Tutorial	Practical		
1	Professional Core Course	PCC-MM302	Iron Making and Steel Making Technology	4	0	0	4	4
2	Professional Core Course	PCC-MM304	Materials Processing	3	0	0	3	3



Sl. No.	Category	Code	Course Title	Hours per week			Total Contact Hours	Credits
3	Professional Elective Course	PEC-MM302	Elective 3	3	0	0	3	3
4	Professional Elective Course	PEC-MM304	Elective 4	3	0	0	3	3
5	Professional Core Course	PCC-MM306	Processing Laboratory	0	0	2	2	1
6	Professional Core Course	PCC-MM308	Modelling and Simulations Laboratory	0	0	2	2	1
7	Humanities	HSMC302	Introduction to Industrial Management	3	0	0	3	3
8	Open Elective Course	OEC302					3	3
9	Mandatory course	MC	Indian Constitution/ Essence of Indian Knowledge Tradition]	-	-	-		0
							Total credits	21

**Semester VII (Fourth year] Curriculum
Branch/Course Metallurgical Engineering and Materials Science**

Sl. No.	Category	Code	Course Title	Hours per week			Total contact hours	Credits
				Lecture	Tutorial	Practical		
1	Project	PROJ401	Project 1	0	0	10	10	5
2	Professional Elective Course	PEC-MM401	Elective 5	3	0	0	3	3
3	Open Elective Course	OEC401					3	3



Sl. No.	Category	Code	Course Title	Hours per week			Total contact hours	Credits
4	Open Elective Course	OEC403					3	3
5	Open Elective Course	OEC405					3	3
6	Engineering Sciences Course	ESC401	Introduction to Instrumentation	4	0	0	4	4
Total credits							21	

**Semester VIII (Fourth year] Curriculum
Branch/Course Metallurgical Engineering and Materials Science**

Sl. No.	Category	Code	Course Title	Hours per week			Total contact hours	Credits
				Lecture	Tutorial	Practical		
1	Project	PROJ402	Project 2	0	0	20	20	10
2	Professional Elective Course	PEC-MM402	Elective 6	3	0	0	3	3
3	Humanities	HSMC 402	Fundamentals of Management for Engineers	3	0	0	3	3
Total credits							16	

TOTAL CREDITS – 160

CHAPTER 2

DETAILED 4-YEAR CURRICULUM CONTENTS

Undergraduate Degree in Engineering & Technology

**Branch/Course: METALLURGICAL ENGINEERING
AND
MATERIALS SCIENCE**

Second year (Third semester onwards)

PROFESSIONAL CORE COURSES



PCC-MM201	Introduction to Materials Engineering	1L:0T:2P	2 credits
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Objectives of the course:

To give the students a broad overview to various aspects of Materials Science and Engineering. Instill interest and curiosity in the discipline.

Detailed contents

Module 1: Design, synthesis & processing, characterization, applications of materials (3 Hours)

Module 2: Failure analysis & forensics of different types of materials starting from common metals and alloys to exotic materials. (3 Hours)

Module 3: Examples and case studies will be taken up and shown to the students. (2 Hours)

Module 4: (in parallel with Modules 1,2 and 3): Demonstrations using sophisticated and state-of-the-art instruments pertaining to aspects of synthesis, processing, characterization and failure analysis will be carried out in the laboratories. (12 Hours)

Module 5: (in parallel with Modules 1,2 and 3): Comprehensive visits/conducted tours to the research laboratories will be carried out (5 Hours)

Module 6: Videos and simulations describing materials and their properties will be shown along with specific and interesting case studies. (3 Hours)

Suggested books

1. Materials Science and Engineering: An Introduction: William D Callister; Wiley, 2014
2. Materials and Design: The Art and Science of Material Selection in Product Design, Mike Ashby and Kara Johnson, 3rd Edition, Butterworth-Heinemann, 2014.
3. Engineering Materials 1 (2011) and 2 (2012), D.R.H. Jones and M.F. Ashby, 4th Edition, Butterworth-Heinemann

Suggested reference books

1. The New Science of Strong Materials or Why You Do Not Fall Through The Floor, J.E. Gordon. Penguin, 1991.
2. Stuff Matters, Mark Miodownik. Penguin, 2014

Course Outcomes

Through this course the students should:

- 1) Have a broad knowledge of the discipline
 - 2) Have an exposure to methods and techniques used in the discipline
 - 3) Understand the flow of courses through the rest of their undergraduate education
 - 4) Develop a preliminary understanding of which courses address which topics in the discipline.
-



PCC-MM203	Phase Transformations	3L:0T:0P	3 credits
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Objectives of the course

To introduce the student to key concepts in Phase transformations and enable an understanding of the steps involved in several important phase transformations.

Detailed contents

Module 1: Definition and types of Phase transformations. (3 hours)

Module 2: Diffusion: Fick's laws of diffusion, solution of Fick's second law and its applications, atomic model of diffusion and role of crystal defects, temperature dependence of diffusion coefficient. (6 hours)

Module 3: Kirkendall effect. Diffusional transformation in solids and diffusionless transformation in solids. (4 Hours)

Module 4: Nucleation and growth - energy considerations; homogeneous nucleation, heterogeneous nucleation, growth kinetics, overall transformation rates. (6 hours)

Module 5: Crystal interfaces and microstructure. Microstructure evolution including recrystallization and grain growth. (3 hours)

Module 6: Precipitation from solid solution: Homogeneous and heterogeneous nucleation of precipitates, the aging curve, mechanisms of age hardening, examples from Al-Cu and other alloy systems (6 hours)

Module 7: Martensitic Transformations: General characteristics of martensitic reactions, similarity to deformation twinning, bain distortion, crystallography and kinetics of martensitic transformations, examples from ferrous and non-ferrous alloy systems. (6 hours)

Module 8: Order-disorder Transformation Examples of ordered structures, long and short range order, detection of super lattices, influence of ordering on properties. (3 hours)

Module 9: Spinodal decomposition (3 hours)

Suggested books

1. Solid State Phase Transformations, V. Raghavan, Prentice Hall India Learning Private Limited, 1987.
2. Phase Transformations in Metals and Alloys, David A. Porter and Kenneth E. Easterling, Third Edition, CRC Press, 2017

Suggested reference books

1. Physical Metallurgy Principles, Reza Abbaschian, Lara Abbaschian, and Robert E. Reed-Hill, Cengage, 2013
2. Mechanisms of Diffusional Phase Transformations in Metals and Alloys, Hubert I. Aaronson, Masato Enomoto, and Jong K. Lee, CRC Press, 2016.



Course Outcomes

After completing this course, the student should be able to:

- 1) Classify phase transformations
- 2) Indicate important steps in different types of phase transformations
- 3) Explain phase transformations from the perspective of thermodynamics and kinetics
- 4) Describe a few well known and studied phase transformations

PCC-MM205	Materials Thermodynamics	3L:0T:0P	3 credits
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Objectives of the course

To highlight the fundamental role of Thermodynamics in describing metallurgical and materials processes. To learn and use thermodynamic functions, rules and relations and interpret thermodynamic plots and diagrams.

Detailed contents :

Module 1: History of thermodynamics, Ideal Gas, Energy and Work, Extensive and Intensive Properties (2 Hours)

Module 2: First Law of Thermodynamics, Internal Energy, Enthalpy, Heat Capacity, Reversible Processes (3 Hours)

Module 3: Second Law of Thermodynamics, Entropy and equilibrium, Reversibility, Heat Engines (3 Hours)

Module 4: Statistical Interpretation of Entropy, Boltzmann Equation (3 Hours)

Module 5: Auxiliary Functions Enthalpy, Free Energy, Chemical Potential, Maxwell's Equations, Gibbs-Helmholtz Equation (3 Hours)

Module 6: Enthalpy as a Function of Temperature and Composition, Third Law of Thermodynamics (3 Hours)

Module 7: Phase Equilibrium in a One-Component System, Equilibrium between Vapor and Condensed Phase, and between condensed phases (3 Hours)

Module 8: Gases: Ideal, Real, van der Waals (3 Hours)

Module 9: Raoult's Law and Henry's Law, Activity, Gibbs-Duhem Equation, Properties of Ideal and Non-ideal Solutions, Regular Solutions (3 Hours)

Module 10: Activity, Phase Diagrams of some Binary Systems (3 Hours)

Module 11: Effect of Temperature and Pressure on the Equilibrium Constant for a gas mixture (3 Hours)

Module 12: Ellingham Diagrams (2 Hours)



Module 13: The Gibbs Phase Rule (3 hours)

Module 14: Electrochemistry, Concentration and EMF, Standard Reduction Potentials, Pourbaix Diagrams (3 Hours)

Suggested books

1. Introduction to Thermodynamics of Materials, 5th Edition, David R Gaskell, Taylor and Francis, 2016.
2. Materials Thermodynamics with Emphasis on Chemical Approach, Hae-Geon Lee, World Scientific Publishing, 2012.

Suggested reference books

1. Thermodynamics in Materials Science, Robert DeHoff, CRC Press, 2006.

Course Outcomes

After completing this course, the student should be able to:

1. Use the various thermodynamic functions appropriately under different experimental situations involving gases, liquids and solids
2. Derive and explain the Gibbs Phase rule
3. Utilize Ellingham diagrams
4. Utilize Pourbaix diagrams

PCC-MM207	Metallography Laboratory	0L:0T:2P	1 credit
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Objectives of the course

To provide hands on experience to prepare the samples for metallographic analysis and understand the basic constituents of microstructures

Detailed contents

(Optical microscopy/microstructure/Hardness)

Module 1: Study of metallurgical microscope (2 hours)

Module 2: Metallographic preparation of metals and alloys (4 hours)

Module 3: Hardness testing of metals on Vickers scale (2 hours)

Module 4: Microscopic examination of steels and non-ferrous metals, interpretation of microstructures, heat treatment of steels (8 hours)

Module 5: Microscopic examination of cast, wrought and welded structures; defects and failures in components (8 hours)

Suggested books

1. R. Haynes, 1984, Springer science + Business Media, New York
2. Douglas B. Murphy, 2001, Wiley-Liss, Inc. USA



Course Outcomes

By completing this laboratory course, students will :

- 1) Get to know and gain hands on experience with various techniques of sample preparation for metallographic analysis of metals and alloys
- 2) Be able to analyse the hardness of different constituents of microstructure using different hardness testers
- 3) Obtain knowledge of quantitative analysis, such as grain size, volume fraction of second phases.

PCC-MM202	Mechanical Properties of Materials	3L:0T:0P	3 credits
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Objectives of the course

To obtain knowledge of stress response of materials, load bearing ability, elastic and plastic deformation. To obtain insight about different mechanical properties of materials under engineering applications

Detailed contents

Module 1: Strength of materials - Mohr’s circle representation, elements of elasticity and plasticity, yield criteria. (9 hours)

Module 2: Deformation of ideal crystal, crystal defects, dislocation theory, dislocations in FCC, BCC, and HCP structures, stress fields and energies of dislocations, forces on and between dislocations, reactions and interaction of dislocations, dislocation-precipitate interactions. (9 hours)

Module 3: Plastic deformation of single crystals and polycrystals. Strain hardening, cold work, recovery and recrystallization. (9 hours)

Module 4: Effect of grain boundaries, yield point phenomenon, strain ageing, dynamic strain ageing. Tensile flow properties, effects of strain rate and temperature, ductile/brittle transition. (10 hours)

Module 5: Introduction to creep, fatigue and fracture mechanics. (3 hours)

Suggested books

1. Mechanical Metallurgy by George E Dieter, McGraw-Hill Education; 3 edition June 1986

Course Outcomes

After completing this course, students will have:

- 1) Knowledge on the load bearing ability of different materials and their response to stress under engineering applications
- 2) Knowledge of deformation and failure mechanism of materials under different types of loading and environment



PCC-MM204	Introduction to Transport Phenomena	3L:0T:0P	3 credits
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Objectives of the course

This course will introduce the concepts of fluid flow, heat transfer and mass transfer with behavior and processing of engineering materials as the focus.

Detailed contents

Module 1: Balance of quantities using elemental volume approach, continuity equation (3 Hours)

Module 2: Newton's law of viscosity, Navier-Stokes equation, laminar flow problems, exact solutions in rectangular, cylindrical and spherical coordinate systems (12 Hours)

Module 3: Friction factors, correlations for turbulent regime, Darcy's law, flow through porous media. (4 Hours)

Module 4: Fundamentals of heat conduction, convection, radiation and their combined effect; steady and unsteady heat transfer, exact analytical solutions, correlations for conjugate heat transfer. (10 Hours)

Module 5: Diffusion and its application in solid state, convective mass transfer, unsteady diffusion in finite and infinite bodies, diffusion and chemical reactions. (8 Hours)

Module 6: Coupled phenomena in transport, Non-dimensional numbers and their correlations of different regimes and analogies.(3 Hours)

Suggested books

1. Transport phenomena, 2nd Edition: R. Byron Bird, Warren E. Stewart and Edwin N Lightfoot; John Wiley & Sons
2. Fundamentals of Momentum, Heat and Mass Transfer, 4th Edition: James R. Welty, Charles E. Wicks, Robert E. Wilson and Gregory Rorrer; John Wiley & Sons

Suggested reference books

1. Transport phenomena in materials processing : D.R. Poirier and G.H. Geiger, TMS
2. Introduction to Fluid Mechanics, 5th Edition: Robert W. Fox & Alan T. McDonald: John Wiley & Sons

Course Outcomes

At the end of this course, the student should be able to

- 1) Pose a problem in transport phenomena as a balance equation
- 2) Make suitable assumptions to make the problem a well defined one
- 3) Identify suitable geometry and boundary conditions for the problem
- 4) Solve simple partial differential equations relevant to transport phenomena
- 5) Plot different parameters and interpret the solutions



PCC-MM206	Physical Metallurgy	3L:0T:0P	3 credits
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Objectives of the course

- To learn about the principles of alloy design, phase diagram and strengthening mechanisms in different metals and alloys.
- To study the fundamental aspects of heat treatment and its influence on properties and applications
- To obtain knowledge about the physical metallurgy of specific and important engineering materials such as ferrous and non-ferrous alloys

Detailed contents

Module 1: Phase diagrams – binary and ternary, principles of alloying, Hume-Rothery rules. Strengthening mechanisms – solid solution, work hardening, precipitation hardening, dispersion strengthening (10 hours)

Module 2: Iron carbon diagram, isothermal, and continuous cooling transformation diagrams; influence of alloying elements on transformation characteristics (10 hours)

Module 3: Heat treatment - annealing, normalizing, hardening and tempering of steels, hardenability (5 hours)

Module 4: Introduction to important ferrous alloys (stainless and special steels, cast irons), aluminium alloys, titanium alloys, copper base alloys (10 hours)

Module 5: Superalloys, shape memory alloys – classification, heat treatment, properties and applications (5 hours)

Suggested books:

1. Physical Metallurgy: Principles and Practice, V. Raghavan, PHI Learning, Delhi, 2008.
2. Physical Metallurgy Principles, R. Abbaschian, R. E. Reed-Hill, Cengage Learning, 2009

Suggested reference books

1. Physical Metallurgy Vols. I, II, III, R.W. Cahn and P. Haasen, North Holland, 1996.
2. Light Metals, I.J. Polmear, Elsevier, 2005

Course Outcomes

By completing this course the student will have:

1. The ability to identify the concepts of alloy design, phase diagrams and strengthening mechanisms and apply them to materials systems
 2. The knowledge of heat treatment and the resulting microstructure in materials
 3. The knowledge of physical metallurgical aspects of important engineering alloys
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PCC-MM208	Physics of Materials	3L:0T:0P	3 credits
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Objectives of the course

To understand the science behind the properties exhibited by materials. To recognize the size scale from which the property originates and hence the impact of various material constituents on the properties of the materials.

Detailed contents

Module 1: Overview of properties of materials (2 Hours)

Module 2: Thermal expansion (1 Hour)

Module 3: Electrical Conductivity, Measuring electrical conductivity (1 Hour)

Module 4: Free electron gas, ideal gas (2 Hours)

Module 5: Free electron theory of metals, Wiedemann-Franz law, Drude model, Successes and Limitations of Drude model, Source of limitations of Drude model (4 Hours)

Module 6: Large systems and Statistical Mechanics, Maxwell Boltzmann statistics (2 Hours)

Module 7: Classical Particles, Quantum particles, History of quantum mechanics, Drude-Sommerfeld model (4 Hours)

Module 8: Fermi-Dirac Statistics, Features of Fermi-Dirac Distributions, comparison with Maxwell-Boltzmann statistics (4 Hours)

Module 9: Anisotropy and Periodic potential, Confinement and Quantization, Density of states (4 Hours)

Module 10: Fermi Energy, Fermi Surface, Fermi Temperature, Electronic contribution to Specific Heat at Constant Volume (2 Hours)

Module 11: Reciprocal space (3 Hours)

Module 12: Wigner Seitz Cells, Brillouin Zones, Allowed Energy Levels, and the Origin of Bands (3 Hours)

Module 13: Calculating allowed and forbidden energy levels, Free electron approximation, tight binding approximation (2 Hours)

Module 14: Electron compounds, Semiconductors, Optoelectronic properties, magnetic properties, phonons (3 Hours)

Module 15: Superconductivity, Bose-Einstein statistics, Meissner effect, BCS theory, Physics of nanoscale materials. (3 Hours)



Suggested books

1. Physics of Materials, Essential concepts of Solid State Physics. Prathap Haridoss, Wiley 2015.

Suggested reference books

1. Solid State Physics, Ashcroft and Mermin, Cengage 2003

Course Outcomes

After completing this course, the student should be able to:

- 1) Explain the origin of the various properties of materials
- 2) Indicate the phenomena that impact specific properties
- 3) Use quantum mechanical approach to explain material properties
- 4) Utilize reciprocal space
- 5) Explain the similarities and differences between classical particles, Fermions, and Bosons

PCC-MM210	Mechanical Metallurgy Laboratory	0L:0T:2P	1 credit
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Objectives of the course

To obtain knowledge on the various mechanical testing machines and mechanical testing methodology

Detailed contents

(Tensile/ Compression/Fatigue/Fracture mechanics)

Module 1: Study of testing machines: Hydraulic and Servo hydraulic universal testing machines, hardness testing machines, impact testing machines. (4 hours)

Module 2: Hardness tests, impact tests, tension tests (10 hours)

Module 3: Fatigue tests. Fracture mechanics test. (10 hours)

Suggested books

Appropriate ASTM standards to be followed. Suggested book to understand associated theory:

1. Mechanical Metallurgy by George E Dieter, McGraw-Hill Education; 3 edition June 1986

Course Outcomes

By completing this laboratory course the student will have:

- 1) Ability to perform Mechanical testing of materials
- 2) Ability to analyse mechanical test data
- 3) Knowledge on various testing machineries



PCC-MM301	Materials Characterization	4L:0T:0P	4 credits
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Objectives of the course

- To obtain knowledge on various structural and microstructural characterization techniques of materials.
- To study the principles, theory and practice of various characterization techniques

Detailed contents

Module 1: Structural Characterization: X ray diffraction Symmetry, Lattice, points groups, Bravais lattices, crystal systems, X-ray generation, Bragg Law, factors influencing intensity, Techniques, Indexing, precise lattice parameter determination, residual stress measurement (18 hours)

Module 2: Microstructural Characterization: Optical Microscopy: Introduction, Contrast, Magnification, Resolution, Numerical aperture, Coherent and incoherent waves, Rayleigh and Abbe's criterion for resolution, Different lens defects, Depth of field, Depth of focus, Bright field microscopy, Dark field microscopy, Phase contrast microscopy, Sample preparation for metallography (18 hours)
Scanning electron microscopy: Electron Specimen interaction, Magnification, Resolution, Depth of field, Construction and principles, Contrast, sample preparation, Different detectors, contrast and image quality (10 hours)

Transmission Electron Microscopy: Construction and principles, sample preparation, Different modes, lens defects and its correction, principles of Diffraction, Ewald spheres, Indexing, Kikuchi lines, Imaging, application on materials
Chemical Characterization: Basic principles of spectroscopic techniques: EDS, WDS, XPS, EELS (10 hours)

Suggested books

1. Fundamentals of Light Microscopy and Electronic Imaging : Douglas B. Murphy and Michael Davidson, Wiley-Blackwell, 2012
2. Scanning Electron Microscopy and X-Ray Microanalysis: A Text for Biologists, Materials Scientists, and Geologists by Joseph Goldstein and Dale E. Newbury, Springer 2011
3. Elements of X-ray diffraction: B.D. Cullity, Pearson Education 2014, 4. Electron microscopy and analysis: P. J. Goodhew, J. Humphreys, R. Beanland, 3rd edition, CRC Press 2000.

Course Outcomes:

After completing this course the student will be able to:

1. Determine crystal structures of materials
 2. Analyse microstructure of materials at different length scales
 3. Analyse defects and fracture surfaces of the tested materials
 4. Indicate instrumentation associated with and operating principles of various techniques
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PCC-MM303	Environmental Degradation of Materials	3L:0T:0P	3 credits
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Objectives of the course

To familiarize the student with the extent and importance of material degradation. To study various aspects of corrosion and its control.

Detailed contents

Module 1: Introduction, Definition, Forms of environmental degradation, Classification of corrosion Importance of corrosion studies and cost of corrosion. (4 Hours)

Module 2:. Corrosion principles: Electrochemical aspects, Thermodynamic aspects of corrosion – Gibbs energy and electrochemical potential (4 Hours)

Module 3: Metal-Electrolyte Interface, EMF series, Nernst relationship and Pourbaix Diagram (6 Hours)

Module 4. Kinetic aspects of corrosion: Corrosion rate, Current density, Exchange current density, Mixed potential theory, Polarization and Passivation. (6 Hours)

Module 5: Forms of corrosion: Uniform Corrosion, Localized Corrosion; Pitting; Crevice Corrosion, Galvanic Corrosion and Protection; Concentration Cells, Intergranular Corrosion; De-alloying, Environmentally assisted failures (SCC, Hydrogen embrittlement; corrosion fatigue), Erosion; Fretting. Experimental methods to identify corrosion susceptibility (9 Hours)

Module 6: Corrosion Measurements and Corrosion Control: Exposure studies, Electrochemical work bench, DC and AC methods of testing, Polarization measurements- Corrosion rate assessment by Tafel's extrapolation method, Linear polarization resistance (LPR). Coatings, Inhibitors, Cathodic and Anodic protection. (9 Hours)

Module 7: Degradation of polymeric and composite materials and its prevention (2 Hours)

Suggested books

- 1) Corrosion Engineering, Mars. G. Fontana, McGraw Hill Education, 2017
- 2) Electrochemical Techniques in Corrosion Science and Engineering. R.G. Kelly, J.R. Scully, D.W. Shoesmith, R.G. Buchheit, CRC Press., 2002

Suggested reference books

- 1) Corrosion: Metal / Environment Reactions, Volume 1, L.L. Shreir, R.A. Jarman, G.T. Burstein, Butterworth-Heinemann, 1994.
- 2) Principles and Prevention of Corrosion, Denny A. Jones, Pearson, 1995.

Course Outcomes

After completing this course the student should be able to:

- 1) Explain the importance of studying corrosion
- 2) Describe the thermodynamic aspects of corrosion
- 3) Describe the kinetic aspects of corrosion
- 4) Indicate the various forms of corrosion
- 5) Explain the measurement and control of corrosion.



PCC-MM305	Non Ferrous Extractive Metallurgy	4L:0T:0P	4 credits
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Objectives of the course

This course will extend the concepts of thermodynamics and kinetics to different processes for extraction of metals.

Detailed contents

Module 1: Basic principles of extractive metallurgy - Thermodynamics and kinetics of extraction processes. (6 Hours)

Module 2: Thermodynamic basis of metal extraction: Ellingham diagrams, predominance area diagrams, Pourbaix diagrams, concept of activity and activity scales. (10 Hours)

Module 3: Slags and mattes and their physico-chemical properties. (6 Hours)

Module 4: Kinetics of extraction process: kinetic theory, reaction rate theory, reaction across interfaces (10 Hours)

Module 5: Sustainable Chemical Metallurgy, Recycling and Recovery from waste. (6 Hours)

Module 6: Hydrometallurgy, electro metallurgy, pyrometallurgy, Ores, mineral processing and beneficiation (8 Hours)

Module 7: Extractive metallurgy of Al, Cu, Zn, Ti, and Mg (10 Hours)

Suggested books

1. The Extraction and Refining of Metals, C. Bodsworth, CRC Press (1994)
2. Principles of Extractive Metallurgy, H.S. Ray and A. Ghosh (1992), Wiley-Blackwell

Suggested reference books

1. Extractive Metallurgy 1: Basic Thermodynamics and Kinetics, Alain Vignes (ISTE Ltd.,)
2. Extractive Metallurgy 2: Metallurgical Reaction Processes, Alain Vignes (ISTE Ltd.,)
3. Extractive Metallurgy 3: Processing Operations and Routes, Alain Vignes (ISTE Ltd.,)
4. Topics in non-ferrous extractive metallurgy, Burkin, Wiley-Blackwell (1980)

Course Outcomes

At the end of the course, the student should be able to

- 1) Apply principles of thermodynamics and kinetics to reactions involving extraction of metals
 - 2) Analyse different extraction processes
 - 3) Solve numerical problems involving thermodynamic and kinetic concepts of relevance to extractive metallurgy
 - 4) Describe the effect of a change in process parameters of different extraction processes
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PCC-MM307	Non Metallic Materials	3L:0T:0P	3 credits
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Objectives of the course

- To introduce the student to the range of non-metallic materials available for Engineering.
- To get an exposure to the techniques associated with the synthesis, processing and characterization of these materials and to become aware of the applications where these materials are preferred.

Detailed contents

Synthesis, processing, structure, properties, characterization, applications, failure modes and deterioration mechanisms of the following will be studied

Module 1: Polymers (10 Hours)

Module 2: Ceramics (10 Hours)

Module 3: Glasses (2 Hours)

Module 4: Composites (12 Hours)

Module 5: Textiles (2 Hours)

Module 6: Adhesives (2 Hours)

Module 7: Foams (2 Hours)

Suggested books

1. Textbook of Polymer Science; Fred W. Billmeyer, Wiley 2007
2. Introduction to Ceramics; Kingery, Bowen, Uhlman. Wiley India Pvt Limited, 2012
Composite Materials: Science and Engineering; Krishan K. Chawla, Springer, 2012

Course Outcomes

After completing this course the student can:

- 1) List the prominent non-metallic materials available for engineering applications
 - 2) Indicate the uses for which these materials are preferred
 - 3) Indicate the structure property relations in these materials
 - 4) Indicate the synthesis and processing steps associated with these materials
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PCC-MM309	Materials Chemistry Laboratory	0L:0T:2P	1 credit
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Objectives of the course

This course introduces chemical analysis of metallic alloys using laboratory practice.

Detailed contents

Module 1: Chemical analysis to identify and quantify different elements in ferrous and non-ferrous alloys by wet chemistry routes (6 hours)

Module 2: Chemical analysis to identify and quantify different elements in ferrous and non-ferrous alloys by instrumental methods (4 hours)

Module 3: Application of chemical analysis to experiments involving mass transfer (4 hours)

Module 4: Application of chemical analysis to experiments involving extractive metallurgy & corrosion (6 hours)

Module 5: Application of chemical analysis to experiments involving fluid property measurements (4 hours)

Suggested books

1. A text book of metallurgical analysis, B C Aggarwal, Khanna Publishers (2002)
2. Corrosion Engineering, Mars Fontana, McGraw Hill (2017)
3. Transport phenomena, B. Bird, W.E. Stewart and E.N. Lightfoot, John Wiley & Sons (2007)

Suggested reference books

1. Instrumental methods of analysis, Willard, CBS Publishers & Distributors (2004)

Course Outcomes

At the end of this laboratory course, the student will be able to

- 1) Identify the major elements in a metallic alloy using chemical methods
 - 2) Quantify specific elements in ferrous and non-ferrous alloys using titration
 - 3) Interpret the results from different spectroscopy instruments to determine chemical composition
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PCC-MM311	Characterization Laboratory	0L:0T:2P	1 credit
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Objectives of the course

To obtain knowledge on basic microstructural analysis of materials and to study microstructural stability

Detailed contents

(XRD/Electron Microscopy/Thermal Analysis)

Module 1: Specimen preparation for scanning electron microscopy, transmission electron microscopy (6 hours)

Module 2: Scanning electron microscopy, Transmission electron microscopy, interpretation of micrographs, SAD analysis (8 hours)

Module 3: X-ray diffraction techniques, phase analysis, indexing of powder patterns (8 hours)

Module 4: TGA, DTA (2 hour)

Suggested books

1. Fundamentals of Light Microscopy and Electronic Imaging : Douglas B. Murphy and Michael Davidson, Wiley-Blackwell, 2012
2. Scanning Electron Microscopy and X-Ray Microanalysis: A Text for Biologists, Materials Scientists, and Geologists by Joseph Goldstein and Dale E. Newbury, Springer 2011
3. Elements of X-ray diffraction: B.D. Cullity, Pearson Education 2014, 4. Electron microscopy and analysis: P. J. Goodhew, J. Humphreys, R. Beanland, 3rd edition, CRC Press 2000.

Course Outcomes

By completing this laboratory the student will be able to:

- 1) Prepare specimens for metallographic analysis
 - 2) Perform microstructural analysis using SEM and TEM
 - 3) Characterize defects and fracture surfaces in materials
 - 4) Carry out thermal analysis to study phase stability
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PCC-MM302	Iron Making and Steel Making Technologies	4L:0T:0P	4 credits
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Objectives of the course

This course introduces the principles of ironmaking and steelmaking

Detailed contents

Module 1: Principles of Iron making and steel making (6 hours)

Module 2: Feasibility of reactions and chemical kinetics (8 hours)

Module 3: Iron making through blast furnace route, steady state heat and material balance in blast furnace (7 hours)

Module 4: Effect of different process parameters on the productivity and quality of pig iron (7 hours)

Module 5: Alternate methods for reduction of iron (6 hours)

Module 6: Steelmaking primary process - pneumatic and hearth, secondary steel making, quality steelmaking, deoxidation, inclusions (12 hours)

Module 7: Control of composition and quality of steel using slags - ferrous slags, physical chemistry of slag metal reactions (10 hours)

Suggested books

1. A first course in iron and steel making, Dipak Mazumdar, Orient Blackswan Pvt. Ltd., (2015)
2. Ironmaking and steelmaking: Theory and Practice, Ghosh Ahindra, Chatterjee Amit, PhiLearning Private Limited, (2001)

Suggested reference books

1. Extractive Metallurgy 1: Basic Thermodynamics and Kinetics, Alain Vignes (ISTE Ltd.,)
2. Extractive Metallurgy 2: Metallurgical Reaction Processes, Alain Vignes (ISTE Ltd.,)
3. Extractive Metallurgy 3: Processing Operations and Routes, Alain Vignes (ISTE Ltd.,)
4. An introduction to modern steel making, R. H. Tupkary, Khanna Publishers (2000)
5. An introduction to modern iron making, R. H. Tupkary, Khanna Publishers (2004)

Course Outcomes

At the end of this course the student will be able to

- 1) Describe the physical and chemical processes that take place during ironmaking and steelmaking
 - 2) Analyse the effect of change in process parameters in ironmaking and steelmaking processes
 - 3) Describe the methods for control of quality in iron and steel production
 - 4) Solve numerical problems involving reaction kinetics and composition control
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PCC-MM304	Materials Processing	3L:0T:0P	3 credits
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Objectives of the course

- To understand the fundamentals of deformation processing related to various manufacturing processes
- To obtain knowledge of various metal joining processes of various engineering alloys
- To understand concepts associated with solidification and its physical metallurgy
- To obtain the basic knowledge of processing of ceramic and glassy materials and their comparison with other materials

Detailed contents

Module 1: Principles of plasticity related to metal forming, cold, warm, and hot working, dynamic recovery and recrystallization. Basic metal forming processes such as Rolling, Forging, Extrusion, Wire Drawing, Sheet metal working. (10 hours)

Module 2: Welding versus other joining processes, Welding processes, welding metallurgy, TTT and CCT diagrams, carbon equivalent, welding of ferrous and non-ferrous alloys, joining of dissimilar metals. (10 hours)

Module 3: Casting. Thermodynamics of solidification, Nucleation and growth, undercooling, dendritic growth, structure of castings and ingots, heat transfer during solidification, types of casting processes. (10 hours)

Module 4: Structure of ceramics and glassy materials, ceramic powder preparations, forming and consolidation processes. (7 hours)

Module 5: Comparison of processing and applications of different materials (3 hours)

Suggested books

1. Principles of Metal Casting by R. W. Haine, C. Loper, and P. C. Rosenthal. McGraw Hill Education, 2001
2. Introduction to Ceramics by Kingery, Bowen, Uhlman. Wiley India Pvt Limited, 2012

Course Outcomes

By completing this course the student will be able to:

- 1) Relate the theory of plasticity to various deformation processing methods
 - 2) Identify the various materials joining processes and their applications
 - 3) Indicate the joining processes of ceramics and glassy materials
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PCC-MM306	Processing Laboratory	0L:0T:2P	1 credit
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Objectives of the course

1. To obtain hands on experience in conducting processing experiments in lab such as casting, welding and forming
2. To obtain knowledge on experimental tools and machinery required to conduct above experiments

Detailed contents

(casting/welding/forming/powder metallurgy etc.)

Module 1: Moulding methods, testing of mould materials, melting practice for a few ferrous and non-ferrous alloys, casting defect analysis. (6 hours)

Module 2: Gas cutting, plasma cutting, manual metal arc welding, submerged arc, electroslag welding, TIG, MIG. (6 hours)

Module 3: Measurement of fundamental parameters in metal forming, calibration of load cells, sheet metal forming, measurement of flow curves, bulk forming,(6 hours)

Module 4: Mixing ceramic powders, making pellets, sintering. (6 hours)

Suggested books

Suggested books to understand associated theory include:

1. Principles of Metal Casting by R. W. Haine, C. Loper, and P. C. Rosenthal. McGraw Hill Education, 2001
2. Introduction to Ceramics by Kingery, Bowen, Uhlman. Wiley India Pvt Limited, 2012

Course Outcomes

After completing this course, the student will be able to:

- 1) Perform laboratory experiments related to different manufacturing processing, along with associated data analysis and interpretation of results
- 2) Identify the tools and machinery involved in the various experiments related to material processing.

PCC-MM308	Modelling and Simulations Laboratory	0L:0T:2P	1 credit
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Objectives of the course

This course introduces computational methods to bring elements of quantification and simulation in the domain of metallurgical and materials engineering using laboratory practice.

Detailed contents

Module 1: Review of programming in high level languages such as Python / Matlab / Mathematica and low level languages such as C / C++ / Fortran (2 hours)



Module 2: Fitting and visualization of multidimensional data (4 hours)

Module 3: Quantification of experimental microstructures using programs as well as software tools, Computational techniques for synthetic microstructures (4 hours)

Module 4: Application of linear algebra towards solution to a system of linear and non linear equations (4 hours)

Module 5: Numerical integration, Numerical solution of partial differential equations, Numerical solution of diffusion equation (4 hours)

Module 6: Introduction to Finite difference, finite element techniques (4 hours)

Module 7: Evaluation of properties from the computed microstructures using mean field and full field approaches; data analytics using principal component analysis (2 hours)

Suggested books

1. Introduction to Computational Materials Science – Richard LeSar, Cambridge University Press (2013).

Suggested reference books

1. Mathematical Methods for Physics and Engineering, 3rd Edition – R.F. Riley, M.P. Hobson, S.J. Bence, Cambridge University Press (2012).
2. Integrated Computational Materials Engineering (ICME) for Metals – Mark F. Horstemeyer, TMS (2012).

Course Outcomes

At the end of this course, the student will be able to

- 1) Use a computer to numerically solve problems in the broad area of materials engineering
 - 2) Quantify experimentally obtained data and microstructures
 - 3) Analyse a problem in the structure – property correlation aspect of materials engineering and attempt a numerical analogue of it
 - 4) Demonstrate hands on ability to work with computer programming and visualization for problems in materials engineering
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PROFESSIONAL ELECTIVE COURSES



PEC-MM	Nanomaterials	3L:0T:0P	3 credits
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Objectives of the course

To recognize the differences between nanomaterials and conventional materials and to become familiar with a wide range of nanomaterials, their synthesis, characterization, properties and applications

Detailed contents

Module 1: History of nanomaterials (2 Hours)

Module 2: Discussion of the Feynman talk “There is plenty of room at the bottom” (4 Hours)

Module 3: Synthesis routes for nano and ultra fine grained materials: bottom up and top down approaches (2 Hours)

Module 4: Specific synthesis routes such as vapor deposition, sol-gel, rapid solidification processing, high energy ball milling, cryo rolling, and equal channel angular extrusion (6 Hours)

Module 5: Thermodynamics of nanomaterials (3 hours)

Module 6: Mechanical property aspects of nanomaterials, inverse Hall-Petch relationship (2 Hours)

Module 7: Specific nano materials and their applications such as:

Carbon nanostructures (Nanotubes, nanohorns, graphene, buckyballs etc) (6 Hours)

Semiconducting nanomaterials – Quantum confinement, Quantum wells, quantum wires and quantum dots. (3 Hours)

Magnetic nanomaterials – super paramagnetism (2 hours),

Ferroelectric, nano ceramics (2 Hours)

Superplasticity (2 Hours)

Nanocomposites (2 Hours)

Module 8: Characterization techniques from the perspective of nanomaterials (4 Hours)

Suggested books

1. Introduction to Nanomaterials, Charles Poole and Frank Owens, Wiley 2007

Course Outcomes

After completing this course, the student should be able to:

- 1) Indicate the differences between nanomaterials and conventional materials
- 2) Indicate how specific synthesis techniques can result in nanomaterials
- 3) Give examples of specific nanomaterials and explain the scientific reasons for the properties displayed by them
- 4) Describe how specific characterization techniques can be used to analyze nanomaterials



PEC-MM	Functional Materials	3L:0T:0P	3 credits
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Objectives of the course

To introduce the student to functional materials and the science behind the performance of the functional material. To enable the student to understand the applications of functional materials

Detailed contents

Module 1: Characteristics and types of functional materials. Crystal structure and Properties. – Effect of size on properties, effect of interfaces on properties (6 Hours)

Module 2: Band structure, Semiconductor devices – Theory, examples and applications of Optically active materials (10 Hours)

Module 3: Dielectrics, piezo- and ferroelectric materials: (10 Hours)

Module 4: Magnetic materials and storage applications. (4 Hours)

Module 5: Smart materials (5 Hours)

Module 6: Applications in electronic, communication, aerospace, automotive, energy industries (5 Hours)

Suggested books

1. Functional Materials: Electrical, Dielectric, Electromagnetic, Optical and Magnetic applications; Deborah D L Chung, World Scientific Publishing, 2010

Course Outcomes

After completing the course the student will be able to:

- 1) Indicate the various type of functional materials
- 2) Explain the principle of operation of the functional material
- 3) Indicate the applications of the functional materials

PEC-MM	Energy Materials	3L:0T:0P	3 credits
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Objectives of the course

To learn the operating principle of several environmentally friendly energy technologies. To identify the material issues relevant to these technologies and to evaluate various operational aspects associated with these technologies.

Detailed contents

Module 1: Energy requirements in a global scale and in the Indian context. (3 Hours)

Module 2: Evaluation of energy sources from the perspective of clean energy. Carbon equivalent (2 Hours)



Module 3:

Introduction to different types of energy storage and conversion devices and technologies. Synthesis and characterization of materials used for these technologies, Properties desired in the materials, Techniques to evaluate the properties and performance, failure modes and analysis, environmental impact of the following technologies:

- Fuel cells (10 Hours)
- Batteries (10 hours)
- Supercapacitors (3 hours)
- Solar energy conversion devices (7 Hours)
- Wind (3 Hours)
- Mechanical Energy storage (2 Hours)

Suggested books

1. Renewable Energy: Power for a Sustainable Future, Godfrey Boyle, Oxford University Press, 2004

Course Outcomes

After completing this course the student should be able to:

- 1) Evaluate an energy technology for environmental friendliness
- 2) Explain the operating principle of several energy technologies
- 3) Indicate the material requirements for these energy technologies
- 4) Demonstrate the ability to understand the characterization, performance, and failure data related to these technologies

PEC-MM	Biomaterials	3L:0T:0P	3 credits
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Objectives of the course

To introduce the student to the range of biomaterials and the science and engineering of biomaterials. To understand constraints associated with the use of biomaterials

Detailed contents

Module 1: Types of biomaterials (2 Hours)

Module 2: Biological environment (4 Hours)

Module 3: Mechanical and physico-chemical properties of biomaterials (8 Hours)

Module 4: Resorbability, bio degradation, Biological responses, compatibility, cytotoxicity, cell biomaterial interactions, associated characterization (8 Hours)

Module 5: Metals, Polymers, Ceramics, Natural biomaterials (12 Hours)

Module 6: Blends, composites, biopolymers, Hydrogels (4 Hours)

Module 7: Drug delivery systems (2 Hours)



Suggested books

1. Introduction to Biomaterials: Basic Theory with Engineering Applications; C.L Agrawal, J.L. Ong, Mark R Appleford, Gopinath Mani, Cambridge University Press, 2013

Course Outcomes

After completing the course, the student will be able to:

- 1) Explain the types of Biomaterials and their relative advantages and disadvantages
- 2) Indicate the constraints placed on the use of materials in biological environments
- 3) Explain the characterization of materials from the perspective of application as a biomaterial

PEC-MM	Electronic Materials	3L:0T:0P	3 credits
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Objectives of the course

To become familiar with the science, synthesis, evaluation, and applications of electronic materials.
To know the manufacturing processes associated with use of electronic materials for devices.

Detailed contents

Module 1: Intrinsic semiconductors. Electron and hole (carrier) concentrations. (2 Hours)

Module 2: Fermi energy level, effect of temperature on Fermi energy(2 Hour)

Module 3: Carrier mobility (1 Hour)

Module 4: Direct vs. indirect band gap materials (2 Hours)

Module 5: Elemental vs. compound semiconductors. Extrinsic semiconductors. Doping – p and n type semiconductors (4 Hours)

Module 6: Carrier concentration and Fermi level as a function of temperature. Drift mobility. Light and heavy doping (3 Hours)

Module 7: Semiconductor diodes – p-n junctions at equilibrium. Forward and reverse bias. I-V characteristics. Band diagram. Diode breakdown mechanisms (6 Hours)

Module 8: LEDs and solar cell materials. Transistors – MOSFETs. Band diagram and channel formation. Threshold voltage. I-V characteristics (6 Hours)

Module 9: Introduction to semiconductor manufacturing – history, process flow, manufacturing goals. Bulk Si crystal growth (4 Hours)



Module 10: Overview of manufacturing technology – oxidation, photolithography, etching, doping, deposition, planarization. Clean room classifications (6 Hours)

Module 11: CMOS manufacturing steps. Process monitoring – blank and patterned thin film measurement. Defect inspection. Electrical testing. Yield monitoring & statistical process control. Definitions of yield, process control, defect density. Process integration. Assembly and packaging (4 Hours)

Suggested books

1. Semiconductor Materials, Devices and Fabrication, Parasuraman Swaminathan, Wiley 2017

Suggested reference books

1. Principles of Electronic Materials and Devices, S. O. Kasap, McGraw Hill Education, 2017

Course Outcomes

After completing this course, the student will be able to:

- 1) Indicate and explain important scientific parameters associated with electronic materials
- 2) Describe different semiconductors and their properties with examples
- 3) Explain the features and functioning of several electronic devices
- 4) Describe the manufacturing processes associated with electronic materials and devices

PEC-MM	Composite Materials	3L:0T:0P	3 credits
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Objectives of the course

- To obtain knowledge on classification, processing, characterization and applications of composite materials.
- To obtain knowledge on mechanical properties and failure mechanisms of composites under loading conditions for engineering applications

Detailed contents

Module 1: Introduction: Definition, history, characteristics, classifications, advantages and limitations, industrial scenario and applications. (2 hours)

Module 2: Material and microstructural parameters of composites. Unidirectional-fibre composites: Fibre characteristics. Longitudinal strength and modulus of composites, minimum and critical fibre volume fractions, factors affecting strength. Transverse strength and modulus. (8 hours)

Module 3: Failure modes. Single and multiple fractures. Short-fibre composites: Stress transfer, critical fibre length. Modulus and strength. Whiskers and whisker reinforced composites. (6 hours)

Module 4: Particulate composites: Large-particle composites and dispersion-strengthened composites. Cermets. Zirconia toughened ceramics. Interface: Interface characteristics and their effects on adhesive, frictional and mechanical bonding mechanisms. Coupling agents and their role on the properties composites. Interface coatings. (10 hours)



Module 5: Properties of composites: Static mechanical properties, fatigue, impact and creep properties, fracture behaviour and damage tolerance. (10 hours)

Module 6: Advanced composites: Nanocomposites, hybrid composites, sandwich composites, in-situ composites, smart composites, self-healing composites, and carbon-carbon composites (4 hours)

Suggested books

1. Composite Materials: Science and Engineering; Krishan K. Chawla, Springer, 2012

Course Outcomes

After completing this course, students will have:

- 1) Knowledge on classification, processing, characterization and applications of various composite materials
- 2) Ability to arrive at different deformation and failure mechanisms of composite materials under different loading conditions in engineering applications

PEC-MM	Fatigue and Fracture Mechanics	3L:0T:0P	3 credits
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Objectives of the course

- To study the different types of fatigue failures and their mechanisms in the engineering applications
- To study the basic theory of fracture mechanics and its relationship with fatigue and creep failure mechanisms
- To understand the damage tolerance approach in the life estimation of structures

Detailed contents

Module 1: Introduction and historical overview, Types of fatigue – low cycle fatigue, high cycle fatigue, very high cycle (giga cycle) fatigue, Fatigue test methods and equipment, Total life approaches based on cyclic stress and cyclic strain, Cyclic hardening and softening in single crystals and polycrystals (10 hours)

Module 2: Crack initiation and propagation, Mechanisms, Macrostructural and microstructural aspects, Use of fracture mechanics in fatigue (10 hours)

Module 3: Local strain approach, effect of different factors on fatigue – Stress concentration, Size, Surface, Temperature, Frequency, Environment, Microstructure, Residual stresses, Fretting, Creep-fatigue interaction, Multiaxial stresses, Thermomechanical loading, Variable amplitude loading, Load sequence, Crack closure (10 hours)

Module 4: Fatigue behaviour of different materials – Metallic materials and weldments, Ceramics, Polymers, Composites, Metallic glasses, Shape memory alloys, Ultrafine grained materials, Nanocrystalline materials, Biomaterials, Metallic foams Case studies on fatigue failures, Design considerations, Methods for fatigue life improvement (10 hours)



Suggested books

1. Fatigue of Materials, Suresh, Cambridge India, 2015
2. Fracture Mechanics, Fundamentals and Applications, T.L. Anderson, CRC Press 2017

Course Outcomes

After completing this course, the student will have:

- 1) The ability identify the characteristic fatigue failures in the engineering structures
- 2) Knowledge of connecting fracture mechanics concepts to fatigue failure
- 3) Knowledge of fatigue failure mechanisms in non-metallic materials

PEC-MM	Failure Analysis	3L:0T:0P	3 credits
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Objectives of the course

- To highlight factors governing the failure of materials and types of failure
- To evaluate the mechanisms and environmental effects associated with failure
- To identify various failures in heat treatments, and deformation processing, and methods to prevent them

Detailed contents

Module 1: Aims of failure analysis. Important factors causing the premature failure of metallic components and structures. Tools and techniques in failure analysis. (10 hours)

Module 2: Fractography. Types of failures; ductile, brittle, fatigue, creep, corrosion, wear. (10 hours)

Module 3: Failure mechanisms. Embrittlement phenomena. Environmental effects. (10 hours)

Module 4: Failures due to faulty heat treatments. Failures in metal forming and welding. Case studies in failure analysis. Prevention of failures. (10 hours)

Suggested books

1. Failure Analysis of Engineering Materials, Charles Brooks, Ashok Choudhury, Charlie R. Brooks, McGraw-Hill Education; 2001
2. Failure Analysis: Fundamentals and Applications in Mechanical Components, Jose Luis Otegui, Springer, 2016

Course Outcomes

After completing this course the student will have:

- 1) The ability to identify the types of failures in engineering components under service
 - 2) Knowledge of the tools and techniques to perform failure analysis
 - 3) The skill set to perform fractographic analysis after various failures
 - 4) The ability to identify different failure mechanisms resulting from manufacturing processes
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PEC-MM	Computational Materials Engineering	3L:0T:0P	3 credits
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Objectives of the course

This course introduces computational methods in the domain of metallurgical and materials engineering.

Detailed contents

Module 1: Software and languages for numerical computation (4 hours)

Module 2: Linear algebraic systems (3 hours)

Module 3: Eigen values problems (3 hours)

Module 4: Curve fitting (3 hours)

Module 5: Root finding (3 hours)

Module 6: Optimization(3 hours)

Module 7: Numerical differentiation, numerical integration (6 hours)

Module 8: Digital processing using fast fourier transforms, principal component analysis etc.,(4 hours)

Module 9: Libraries for accurate and fast numerical computation (4 hours)

Module 10: Application of computational methods to study structure of materials at different length scales, transport phenomena, phase transformations and kinetics of reactions. Examples can be drawn from processes and topics covered in core curriculum of materials engineering (7 hours)

Suggested books

1. Introduction to Computational Materials Science – Richard LeSar, Cambridge University Press (2013).
2. Applied numerical methods for engineering using matlab and C – R.J. Schilling and S.L. Harris, Cengage Learning (2007)

Suggested reference books

1. Mathematical Methods for Physics and Engineering, 3rd Edition – R.F. Riley, M.P. Hobson, S.J. Bence, Cambridge University Press (2012).
2. Modeling in materials processing – J.A. Dantzig and C.L. Tucker III, Cambridge University Press (2001)

Course Outcomes

At the end of the course the student should be able to

- 1) Analyse a metallurgical problem to create a well posed numerical problem
- 2) Identify initial and boundary conditions of a problem relevant to materials domain
- 3) Propose a solution procedure for a numerical problem in the domain of materials engineering
- 4) Demonstrate ability to quantify a materials engineering problem through numerical analysis



PEC-MM	Surface Engineering	3L:0T:0P	3 credits
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Objectives of the course

To understand the need for Surface Engineering and to become familiar with the techniques associated with Surface Engineering

Detailed contents

Module 1: Need for engineered surface, definition and principles (2 Hours)

Module 2: Conventional surface hardening methods (2 Hours)

Module 3: Methods involving no change in the chemical composition of the surface (4 Hours)

Module 4: Methods involving change in chemical composition of the surface (4 Hours)

Module 5: Application of advanced techniques such as ion and electron beam towards creating new engineered surface (6 Hours)

Module 6: Controlled high quality surface modification by techniques such as CVD, PVD. Plasma, laser, ion bombardment (6 Hours)

Module 7: Effect of process variables and structure -property correlations (4 hours)

Module 8: Thermo - chemical, thermo - mechanical and thermal processes (4 Hours)

Module 9: Treatments for industrial components (4 Hours)

Module 10: Case studies (4 Hours)

Suggested books

1. Introduction to Surface Engineering, P. A. Dearnley, Cambridge University Press, 2017

Course Outcomes

After completing this course, the student will be able to:

- 1) Indicate the need for surface engineering
 - 2) Indicate the different methods of surface engineering
 - 3) Differentiate between the methods used and indicate their relative merits
 - 4) Understand aspects associated with industrial applications of surface engineering
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PEC-MM	Foundry Technology	3L:0T:0P	3 credits
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Objectives of the course

- To study the science and engineering of casting.
- To study the various processing techniques and heat treatment of castings

Detailed contents

Module 1: Pattern making, moulding and core making, Metal mould casting, gating and risering, melting (10 hours)

Module 2: Casting defects and quality control (6 hours)

Module 3: Heat treatment of castings (12 hours)

Module 4: Use of CAD CAM in foundries (12 hours)

Suggested books

1. Principles of Foundry Technology, P. Jain, McGraw Hill, 2017

Course Outcomes

After completing this course the student have:

1. Knowledge of technical procedures of making castings
 2. The ability to analyse defects, microstructure and phases in castings
 3. The ability to perform computational analysis of castings
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PEC-MM	Powder Metallurgy	3L:0T:0P	3 credits
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Objectives of the course

This course introduces the particulate technology to create components from powder route.

Detailed contents

Module 1: Powder production (5 hours)

Module 2: Powder characterisation (5 hours)

Module 3: Powder treatment (4 hours)

Module 4: Powder compaction (3 hours)

Module 5: Pressureless powder shaping (3 hours)



Module 6: Sintering theory, sintering kinetics, sintering technology, consolidation (10 hours)

Module 7: Defects in P/M route and their control, treatment of powder metallurgy components (5 hours)

Module 8: Testing and quality control, metallic and ceramic P/M components, application of P/M products (5 hours)

Suggested books

1. Powder metallurgy: science, technology and materials – Anish Upadhyaya, G.S. Upadhyaya, Universities Press (2011)
2. Power metallurgy : science, technology and materials – P.C. Angelo, R. Subramanian, Prentice Hall India Learning Pvt. Ltd., (2008)

Suggested reference books

1. Volume 7: Powder Metallurgy, ASM Handbook – P.K. Samal and J.W. Newkird, ASM (2015)
2. Powder Metallurgy Science – R.M. German, Metal Powder Industry (1994)

Course Outcomes

At the end of this course, the student will be able to

- 1) List different stages of manufacturing using the powder metallurgy route
 - 2) Describe characteristics of a P/M component
 - 3) Describe the consolidation process during P/M route and identify the defects that arise
 - 4) Analyse the material and design needs of a P/M component
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MODEL CURRICULUM

for

MANDATORY COURSES (NON-CREDIT)

[January 2018]



ALL INDIA COUNCIL FOR TECHNICAL EDUCATION
Nelson Mandela Marg, Vasant Kunj, New Delhi 110 070

www.aicte-india.org



All India Council for Technical Education

Mandatory Courses & Activities (Non-Credit)

I. List of Activities and Mandatory Courses

1. Physical and Health

Physical Activities
NCC

2. Culture

Learning an art form
Heritage
Intangible Cultural Heritage

3. Literature & Media

Literature, Cinema and Media
Group reading of classics

4. Social Service

Social Awareness
Social Service

5. Self Development

Spiritual, Mindfulness & Meditation
Religion and Inter-faith
Human Values
Behavioural and Interpersonal skills
Lectures

6. Nature

Nature Club
Environment Protection (non-credit course)

7. Innovation

Project based – Sc. Tech., Social, Design & Innovation

8. Mandatory Courses (non-credit)

Constitution of India
Universal Human Values – I (during Induction Program)
Environment Sc.
Essence of Indian Knowledge Tradition
Learning an art form (during Induction Program)



II. Curricular Structure

[A separate Guide to Induction Program is also attached at **Appendix A** in Volume I of Model Curriculum (UG)]

Semester 1

First 3-weeks – Mandatory Student Induction Program

Please refer to Appendix –A for guidelines and details

After first 3 weeks

- Based on student interest – the above may be continued
- Universal Human Values Groups – Meet once a week with 1st year students with the same faculty mentor & senior student guide.

Semester 2 to 4

- Every student should register for some activity mentioned above in every semester. Spend 3-5 hours per week on the activity.
- Environment Science (mandatory non-credit course)

Semester 5 to 8

- Every student should register for some activity mentioned above in every semester. Spend 3-5 hours per week on the activity.
- Constitution of India (mandatory non-credit course)
- Essence of Indian Knowledge Tradition (mandatory non-credit course)

For mandatory non-credit courses, these will be graded as Pass or Fail (P/F). Thus the grades obtained will not affect the grade point average. However, they will appear on the grade sheet.

For activities, suitable registration system in case of the semesters will be developed.

III. Descriptions of Activities

A brief description of all the suggested activities is presented below on the following two points.

1. Goal (intended to be achieved through the activity)
2. Description and details of the activities



These activities are listed under following 7 heads:

1. Physical and Health
2. Culture
3. Literature and Media
4. Social Service
5. Self development
6. Nature and Environment
7. Innovation

1. Physical and Health

Physical Activities (sports & games, gardening, tree plantation and Yoga)

Physical activity means any bodily movement produced by skeletal muscles requiring energy expenditure. Walking, gardening, briskly pushing a baby stroller, climbing the stairs, playing soccer, or dancing are all good examples of being active. Activities can be considered vigorous, moderate, or light in intensity. Activity makes one breathe harder and one's heart beat faster.

Moderate physical activities include:

- Walking briskly (about 3½ miles per hour)
- Bicycling (less than 10 miles per hour)
- General gardening (raking, trimming shrubs)
- Dancing
- Golf (walking and carrying clubs)
- Water aerobics
- Canoeing
- Tennis (doubles)

Vigorous physical activities include:

- Running/jogging (5 miles per hour)
- Walking very fast (4½ miles per hour)
- Bicycling (more than 10 miles per hour)
- Heavy yard work, such as chopping wood
- Swimming (freestyle laps)
- Aerobics
- Basketball (competitive)
- Tennis (singles)

Physical activity or regular exercise can improve one's health and reduce the risk of developing several diseases like type 2 diabetes, cancer and cardiovascular disease. The physical activity ratio (PAR) is defined as the ratio between energy expenditure corresponding to a sedentary or physical activity (kJ/min) and basal metabolic rate [(BMR) kJ/min].



For health benefits, physical activity should be moderate or vigorous intensity. Physical inactivity has been identified as the fourth leading risk factor for global mortality causing an estimated 3.2 million deaths globally.

(a) Games and Sports

Games and sports are necessary and useful for all. Games play an important part in life. Education is incomplete without games. Games are necessary to keep the body fit and trim. Moreover, they provide recreation. As a result, one feels smart and cheerful throughout the day. If one is cheerful and healthy, he or she is able to get the best out of life. A player really enjoys life. For him, life is a song and a beauty. On the other hand, an unhealthy man cannot enjoy life. Games teach us the lesson of discipline, team-work, patience and punctuality. In the playground, the players obey the captain and abide by the rules of the games. Games also teach us that we should play a game for game's sake, not for victory or defeat. A healthy man is always hopeful and cheerful.

(b) Gardening

One cannot eat, drink, or breathe without the plants. No plants means no life and that can't be healthy! Daily gardening chores like watering, weeding, trellising, mulching, and harvesting are great ways to augment an exercise regimen. Plants reduce pollution by reducing the amount of carbon dioxide in the air and giving off oxygen – just what we need to survive! This is called photosynthesis.

(c) Tree Plantation

The trees are extremely important and have always been needed for developing the human condition and lifestyle. It doesn't make us believe that without trees we humans would not exist on this beautiful earth. So, trees are important for life as we know it and are the earth troops creating up an environmental Frontline. There are various importances of trees such as Trees Produce Oxygen, Trees Clean the Soil, Trees Control Noise Pollution, Trees Slow Storm Water Runoff, Trees Are Carbon Sinks, Trees, Shade and Cool, Trees Act as Windbreaks, Trees Fight Soil Erosion, Trees Increase Property Values and many more. There are also numeral of the benefits of the trees except mention above such as Save Water, conserve energy, reduce violence, add unity, provide wood and save earth from an earthquake. You should participate in Plant to “Save Trees to Save Life”. Save trees to reduce global warming, reduce the carbon footprint and pollution as well as a clean environment.

Activity:

Planting of fruit trees should be encouraged. Besides these, shady trees or trees which invite birds should be planted. Ornamental plants must be avoided.

(d) Yoga:

The benefits of Yoga are many. It brings in calmness of mind besides the physical fitness by doing Yoga Asanas.



NCC

Standard

2. Culture

Learning an Art Form

Cultivation of arts is an integral part of the development of human beings since the arts are what make us most human, most complete as people. They offer us the experience of wholeness because they touch us at the deepest levels of mind and personality. They come into being not when we move beyond necessity but when we move to a deeper necessity, to the deeper human need to create order, beauty and meaning out of chaos. They are the expressions of deepest human urges, imperatives and aspirations.

While enriching the process of learning through enhanced perceptual and cognitive skills, learning of arts promotes self-esteem, motivation, aesthetic awareness, cultural exposure, creativity, improved emotional expression, as well as social harmony and appreciation of diversity. They promote an understanding and sharing of culture, and equip the learners with social skills that enhance the awareness and respect of others.

Each institution will offer a range of introductory courses in different art forms: music, dance, theatre, painting, and other art forms. Care should be taken to give adequate representation to local and regional art forms in which our culture abounds. For example, Banaras has local traditions in vocal music like *Chaiti*, *Hori*, *Kajri* and *Birha*. An institution in Banaras area can offer courses on these art forms apart from regular classical and semi-classical vocal music forms. Similar local art tradition can be utilized in different cities and regions. This will, in turn, also ensure wider community involvement/interaction with the institution. Students will be given an option to choose a particular art form, and learn and practice it under an artist-instructor. At the end of the course, a student should be able to demonstrate basic proficiency in that particular art form. Contact hours per week should be 3-4 hours.

Towards the end of the course, the institution can organize a function/program in which all the students publicly demonstrate their skills.

This will be a mandatory non-credit course and would run during Induction Program.

Heritage (Visit to museum, archaeology sites, cultural walks, tours, local traditions)

Culture takes diverse forms across time and space. This diversity is embodied in the uniqueness and plurality of the identities of the groups and societies making up humankind. As a source of exchange, innovation and creativity, cultural diversity is as necessary for humankind as biodiversity is for nature. In this sense, it is the common heritage of humanity and should be recognized and affirmed for the benefit of present and future generations.

Cultural heritage is a manifestation of the ways of living developed by a community and passed on from generation to generation, including customs, practices, places, objects, artistic expressions and values. This heritage is manifested not only through tangible



forms such as artefacts, buildings or landscapes but also through intangible forms such as oral traditions, performing arts, customs and rituals etc.

Cultural heritage is a fundamental source of individual and group identity, vitality, and solidarity. Cultural heritage has a pivotal role to play shaping us into what we are. It is a universal process by which we maintain connections with our pasts, assert our similarities with and differences from one another, and tell our children and other young people what we think is important and deserves to be part of the future. Our heritage and culture is what gives us faith, will and hope. Further, creativity draws on the roots of cultural tradition, but flourishes in contact with other cultures. For this reason, heritage in all its forms must be preserved, enhanced and handed on to future generations as a record of human experience and aspirations, so as to foster creativity in all its diversity and to inspire genuine dialogue among cultures.

The objective of the course is to sensitize our youth to the significance and importance of cultural heritage and make them as agents/actors actively involved in the process of preserving and nurturing them.

The course will involve study of archeological sites, monuments and buildings, museums and local traditions. Preference should be given to local sites, monuments and traditions. Students can alternatively be asked to study such sites and traditions in their home regions. An institution can also adopt an archeological site / monument / custom in its area and involve students in its preservation and promote awareness about it among people at large. Students should be asked to identify an archeological site/monument/local custom and tradition/ artifacts in a museum, to conduct a research to gain information about various aspects related to them and to write project reports or to prepare short documentaries.

For example, the following guidelines (suggested by UNESCO) can be adopted for such a study:

(a) Identification of the Element

- Name of the element
- Physical location of the element
- Description

(b) Characteristics of the Element

- Associated tangible elements
- Associated intangible elements
- Language
- Perceived origin

(c) Persons and Institutions Involved with the Element

- Practitioners
- Other participants (custodians, holders)
- Modes of transmission
- Concerned organization(s)



(d) State of the Element: Viability

- Threats to enactment and transmission
- Availability of associated tangible elements
- Viability of associated tangible and intangible elements
- Safeguarding measures in place (Based on UNESCO Report)

Based on their cumulative project experience, they can also develop and plan heritage walk and tours highlighting the cultural heritage of a particular place. Such an exercise allows the students to conceptualize places and issues not only in the local area but also beyond their immediate experience. Students are usually familiar with some aspects of indigenous culture and, therefore, may find it interesting to learn more about it through the cultural heritage.

The course will create among students a better understanding and appreciation for our cultural diversity and plurality; and this, in turn, would promote and encourage among them a spirit of mutual understanding, cooperation and respect for one another and the diverse ways of life, thus leading to reduced social conflict and tension which has become the bane of our society. By ensuring harmonious interaction among people and groups with varied backgrounds, it will promote social cohesion and stability thus bringing in alienated and marginalized minority groups into the mainstream of national activity, and make them stakeholders and equal partners in the task of nation-building.

Intangible Cultural Heritage (Festivals, Food ways, Local Games)

As part of our rich intangible cultural heritage, foodways, fares and festivals, local games and sports are important sources for discovering the social and cultural values of our people and understanding the inner dynamics of our society, as these are sites where we witness the most significant and intimate representations of our society's self-perception— how our society perceives itself. These traditions have shaped and strengthened our social and cultural identities, and also the notion of community at the local, regional, and national levels. They have played a significant role in the making of our social life, and through them we have constructed for ourselves, individually and collectively, a sense of shared lived past and group identity. They facilitate the transmission of a culture's most deeply held values, from one generation to another and their continuity or discontinuity helps us to understand the changing social structure and culture of a society. For example, each community has its own foodways, and their overall health, well-being and cultural continuity are directly related to their ability to eat traditional foods and continue their traditional food practices. These traditional foods and food practices are deeply intertwined with their cultures and value systems, and play an important role in religious ceremonies and spirituality. Similar is the case with fares and festivals, and local games and sports. These traditions are bound up with rituals, customs, beliefs, and often also with trade, craft and professions. They are not mere superstitious rituals often condemned and denounced as being regressive, stagnant and backward, but repositories of our indigenous knowledge and wisdom which have evolved over centuries, and they still continue to serve social and cultural functions. This knowledge has been the basis for agriculture, food preparation, health care, education, conservation and the wide range of other activities that sustain societies in many parts of the world.



Most of these traditions are either on the verge of extinction or undergoing drastic changes due to globalization, acculturation, migration, questions of identity related to social mobility to conform to a higher social order or simply because the context in which these traditions originated or were conceived no longer exist and their effectiveness or need seems no longer relevant. For example, while the agro-ecological and food systems offer some signs of resilience and adaptation, a range of factors are increasingly threatening these systems and peoples' well-being. The knowledge and skills of elders concerning traditional food preparation, and the use of traditional herbs and plants for healing purposes have not been passed on to the next generation and is at risk of being lost and disappearing altogether from reservation life and culture.

The course aims at exposing students to these traditions, and making them aware of the veritable treasure house of indigenous knowledge which can be utilized as resource for realizing a vision of sustainable future.

Each locality/region our Indian sub-continent abounds in a rich variety of food-ways, fares and festivals, games and sports. Students should be asked to identify one of these traditions and study them in detail. For example, the following guidelines can be adopted in the study of food-ways:

- To study and document the indigenous knowledge and wisdom of everyday food habits and food items consumed;
- To study and document the prevalent social practices and beliefs regarding traditional foods;
- To study and document the feasts on religious and social occasions of different communities;
- To identify and document the food items consumed by different communities and determine their nutritional values;
- To conduct chemical analysis of food ingredients;
- To identify and document the kitchen generated health ingredients used by different communities;
- To find out the uses of leftover food stuff of different communities;
- To develop hygienic food chart for people ailing and suffering from different metabolic disorders; and
- To develop suitable communication strategies to effectively disseminate traditional knowledge regarding food habits.

Similarly, in the case of fares and festivals, and games and sports one could study how these traditions create a sense of community bonding and lead to the rules of commensality and social interaction and behavior. Suitable guidelines along the lines of foodways can be developed and adopted for such a study.

At the end of the course, students will be required to submit a detailed project report. Options should be given to the students to make short documentaries and films on these traditions.



3. Literature & Media

Literature, Cinema and Media (workshop, reading multiple news sources, analyze ads)

The objective is to inculcate the habit of active (or interactive) consumption of the best content available in literature, films and media, rather than passive consumption.

Description

Literature is perhaps as old as history or may be older and it is difficult to think of a fully educated person without any exposure to the best of the world literature (not just the literature of their own country or in their own language). Cinema is more recent and mass media is even more recent, but all these have a vital role in today's society. The problem is that the content available easily to most people (partly due to extensive promotion) caters to the lowest common denominator. Engineering students should be encouraged to read the best of the world literature and watch the best of the world cinema (regardless of their viewpoints). They should also be made aware that news is best collected from different sources, which don't necessarily agree, so that they can understand the true meaning of democracy and also learn to form educated opinions about various topics based on the information from diverse sources. They should learn that being opinionated without being properly informed (say, by relying only on one source of news on TV based on TRPs) is not the right way to be a good citizen. They should get the experience of their opinion being contradicted by the most reliable evidence, so that they realize that there is no shame in changing a wrong opinion in the light of overwhelming evidence. For that, they will also have to learn how to find out the degree of reliability of different sources. One way to achieve this is to conduct workshops where students, aided by invited experts, read news from different sources, watch the best cinema and read or watch different media sources. They can then discuss these with their peers and with the invited experts and learn to talk peacefully with people of different viewpoints, as well as learn to form their own opinions. They should then be encouraged to write about their takeaways from these discussions or their opinions and their reasons for forming those opinions. Such activities can counter the current culture of being 'trolls' on the social media, for example. Instead, we should have citizens who give due respect to their fellow citizens and learn to analyze, discuss and reach conclusions in an agreeable manner, without unnecessary feelings of bitterness and enmity.

Another related exercise could be to read or watch advertisements and then analyze them in terms of the biases they promote (such as the desirability of fair skin) or the deception they indulge in to psychologically compel consumers to buy things they don't really need. Some advertisements even promote the habit of treating fellow human beings with contempt for being different from them (even in terms of possessing the products they are promoting). A well-educated citizen should be less susceptible to such practices in advertisements. Advertisements are just one example. Something similar could be done with all kinds of propaganda material

Group Reading (saamuhik vaachan) of classics.

This will make group to read one or two books during a semester.

Process: An hour may be fixed for a small group for a particular classic. Group sits and each person reads aloud (if possible with proper modulation) taking turns. This if done



properly for an hour one may complete 30-40 pages in an hour. A normal classic can be finished in 15 to 20 days. If serious books on philosophy etc. are taken up a discussion can be held after every idea is complete.

4. Social Service

Social awareness (Artisans-relates to engg., visit to hospitals, orphanages, police station, courts, trauma centers, consumer forums)

Human beings live in relationship with their family members and with others in the society. As a society, mankind strives to achieve ordered and organized life through which an environment of cooperation and coexistence is expected. A healthy society creating an environment of fearlessness is a key for the mankind to achieve higher goals because it is society which makes us most human, most complete as people.

Although as a society, our expectation is fearlessness, but due to lack of understanding of our role in a society, we fail to fulfill the expectation. The social awareness activity shall promote an understanding and sharing of issues of societal problem through exposure to variety of artisans and different kind of organizations. It is expected that this exposure will enable the learners to appreciate social issues, problems and challenges.

Each institution will offer a range of introductory activity based courses focusing on local artisans related to engineering so that students are sensitized to appreciate their problems and can take up some of the problems to solve while they do their regular studies. This course shall also include visits to visit to hospitals, orphanages, police station, courts, trauma centers, consumer forums so that they get exposed to different facets of societal problems. Care should be taken to give adequate representation to local and regional organizations and artisans. For example, Banaras has local traditions in *Banarasi Saari*, Toy making, etc and has almost all types of organizations. An institution in Banaras area can offer courses on these artisans. This will, in turn, also ensure wider community involvement/interaction with the institution. At the end of the course/semester, a student should be able to identify a social issue, prepare project report and give presentation on the selected issues. Contact hours per week should be 3-4 hours. Towards the end of the course, the institution can organize an exhibition in which all the students publicly demonstrate findings of their reports and their future plan of actions.

Social Service (teach in neighborhood, adopt an underprivileged school, village stay / visit (NSS), cleanliness drive, and skill transfer)

5. Self Development

Spiritual, Mindfulness and Meditation

The human mind especially among the youth needs to transcend its preoccupation with negative experiences such as fear, anxiety, anger and obsession and to become more comfortable with the experience of compassion, acceptance and forgiveness. The student's attitude of acceptance towards negativity, aggression and turbulent emotions should be diffused with the practice of mindfulness. Rather than suppressing emotions or by indulging in them, the student be taught to handle such vibes with acceptance and generosity and with the observation of the self.



A mindful state has to be achieved when negative thoughts and experiences are becoming more personalized and do not serve as dictators of subsequent feelings and activities (e.g. suicide attempts, violence etc.). Both concentrative and insight meditation techniques may be practiced for 10-day sessions during every two months. Behavioral techniques of self monitoring should also be practiced to observe the stream of consciousness from the perspective of a vigilant but detached observer.

The students should be trained to practice different models of mindfulness and meditation so as to elicit a state of deep physical and behavioral relaxation. They may work on selectively influencing or changing the symmetry in hemispheric brain activity. Positive addiction, meta-cognitive practices etc. are exercised to make the students experience the universal human capacity through spiritual experiences.

The students may learn to turn-off or bypass the cognitive processing of usual daily pre-occupations and concerns, allowing access to mindful, spiritual and meditative state of self realization.

Activities:

Reading (10 books/ narrations)

Exercises (Mindfulness based Stress Reduction (MBSR) and 10 more)

Sessions: multiple 10-day sessions may be organized over a semester.

Religion and Inter-faith

The objective is to gain knowledge about the beliefs and philosophies of different religions on issues like environment, gender equality, unity, financial equality etc.

The scholars of different religious and philosophical sects should be invited to talk about the issues mentioned above. Efforts should be made to ensure that such talks and discourses should stay clear-off making a critical study on these areas.

Following activities must be included.

- Reading of books on religious texts of different faiths by famous authors. (Reading methods may be as suggested under 'book reading'.)
- Organizing lecture on interfaith issues covering philosophies and chronology and contemporary situations world over at a given time.

Universal Human Values - See under 8.2 (mandatory non-credit course)

Behavioral and Interpersonal skills (non-verbal skills / behaviours, non-aggression)

Each individual has behavior patterns that are shaped by the context of his or her past. Most often, adapting the behaviour to the changing context of the reality a person lives in becomes difficult which may lead to the reduction in personal effectiveness and natural self-expression. The main focus of this course is to equip the students with useful approaches to help in the deeper understanding of self and help individuals empower themselves to be the source of their own growth and development. The course will help students to learn effective communication skills, Group and team building skills and will help them learn the goal setting process and thus become more effective in achieving their goals.



The broader objective of this course is to make the students aware about the different facets of self and to help them learn skills to strengthen their inner capacities. So that they are able to understand themselves, think and act effectively, to be able to communicate in an effective manner and to learn to lead and to form an effective team. The specific objectives, however, are as following.

- To help the students to understand their real self by recognizing different aspects of their self-concept that will lead to an increased self-confidence.
- To train the students for communicating effectively in both formal as well as in informal settings.
- To help the students to understand the importance of non-verbal aspects of effective communication.
- To help the students to understand Emotion and emotional intelligence, Managing ones' own emotional reservoirs, effective dealing with emotions at work
- To facilitate the students in understanding the formation and function of group and team and to help them to learn the skills of a successful leader.
- To help the students in understanding and practicing the goal setting process by recognizing the importance of each step involved in goal setting. The activities involved are designed to facilitate their career goal decision making.

The activities to achieve the above objectives can be suggested as follows.

- Motivational lectures
- Group Discussions/activities
- Case Study
- Games/Stimulation Exercises
- Role-Playing
- Mindfulness training.

Lectures

The objective is for students to get exposure to a diversity of areas other than their own field of study, but in a less formal and more engaging setup. These areas could be from science, engineering, social sciences, arts or even politics.

Although practice is important and lectures are already part of every academic curriculum, engineering students usually get exposure to only a small set of areas which are part of their curriculum. To be good citizens and human beings, as well as to be better engineers or scientists, they should be exposed to other diverse areas. For this purpose, renowned experts and practitioners from other areas of science, engineering, social sciences or arts should be invited to colleges to give lectures specially targeted at engineering students to help open up their minds. These lectures should not be of the kind one gets in classrooms, but more like invited talks or tutorials at research conferences, or lectures based on personal experiences of these renowned experts and practitioners. One of the models for these could be the lectures of, say, the famous physicist Richard Feynman. Some of the TED Talks can also serve as models for this. These lectures should serve as kinds of bridges between theory and practice of activities in areas other than their own. They should be motivational, in the sense that they should help students willingly and happily take up activities in at least one or two of the diverse areas. They should help in producing more rounded human beings who can interact



fruitfully with other kinds of people, not just with other engineers of their own branches. In addition, the students should feel the thrill of meeting people who have not only excelled in their fields, but have motivated others to do so.

Even the more articulate politicians could be invited to present their view of the world to students, according to their different ideologies. But if this last part is done, it must be ensured that all major distinct ideologies are represented, so that students get to know very different viewpoints directly from their committed supporters. Since students are going to be citizens and voters, they should know more about political viewpoints that they can get from popular news channels or from social media.

6. Nature

Nature club (bird watching, recognizing plants at institute/at home, recognizing local animals, appreciating biodiversity)

Impart knowledge and inculcate the habit of taking interest and understanding biodiversity in and around the college campus. The students should be encouraged to take interest in bird watching, recognizing local plants, herbs and local animals. The students should be encouraged to appreciate the difference in the local biodiversity in their hometown, in the place of their study and other places they visit for vacation/breaks etc.

Following activities must be included.

- Identify a tree fruit flower peculiar to a place or having origin from the place.
- Making high resolution big photographs of small creatures (bees, spiders, ants, mosquitos etc.) especially part of body so that people can recognize (games on recognizing animals/plants).
- Videography/ photography/ information collections on specialties/unique features of different types of common creatures.
- Search and explore patents and rights related to animals, trees etc.
- Studying miracles of mechanisms of different body systems.

Environment Science (Mandatory non-credit course)

We as human being are not an entity separate from the environment around us rather we are a constituent seamlessly integrated and co-exist with the environment around us. We are not an entity so separate from the environment that we can think of mastering and controlling it rather we must understand that each and every action of ours reflects on the environment and vice versa. Ancient wisdom drawn from Vedas about environment and its sustenance reflects these ethos. There is a direct application of this wisdom even in modern times. Idea of an activity based course on environment protection is to sensitize the students on the above issues through following two type of activities.

(a) Awareness Activities:

- i) Small group meetings about water management, promotion of recycle use, generation of less waste, avoiding electricity waste
- ii) Slogan making event



- iii) Poster making event
- iv) Cycle rally
- v) Lectures from experts

(b) Actual Activities:

- i) Plantation
- ii) Gifting a tree to see its full growth
- iii) Cleanliness drive
- iv) Drive for segregation of waste
- v) To live some big environmentalist for a week or so to understand his work
- vi) To work in kitchen garden for mess
- vii) To know about the different varieties of plants
- viii) Shutting down the fans and ACs of the campus for an hour or so

7. Innovation

Project based - Sc., Tech, Social, Design & Innovation

Many students, when they enter engineering, are full of enthusiasm to understand new areas, to build systems and to experiment and play with them. This enthusiasm is to be tapped and to direct it to exploration and sustained pursuit by the student which may result in development of a working system, a prototype, or a device or material, etc. They are not required or even expected to produce research or an innovation.

Students may be encouraged to take up projects which are aimed at providing solutions to societal problems, reduce drudgery and improving efficiency in rural work, green technologies, utilization of rural and urban waste, sanitation and public health, utilizing non-conventional energy sources, technologies for the benefit of the differently abled people and technologies ready to be implemented in the Institute.

Two types of activities may be undertaken under this

- (a) Exposure to social problems (which are amenable to technological solutions)
- (b) Design & Innovation (to address above problems)

After this students be encouraged to undertake technology projects of social relevance.

8. Mandatory Courses (non-credit)

Constitution of India - Basic features and fundamental principles

The Constitution of India is the supreme law of India. Parliament of India can not make any law which violates the Fundamental Rights enumerated under the Part III of the Constitution. The Parliament of India has been empowered to amend the Constitution under Article 368, however, it cannot use this power to change the “basic structure” of the constitution, which has been ruled and explained by the Supreme Court of India in its historical judgments. The Constitution of India reflects the idea of “Constitutionalism” – a modern and progressive concept historically developed by the thinkers of “liberalism” – an ideology which has been recognized as one of the most popular political ideology and result of historical struggles against arbitrary use of sovereign power by state. The



historic revolutions in France, England, America and particularly European Renaissance and Reformation movement have resulted into progressive legal reforms in the form of “constitutionalism” in many countries. The Constitution of India was made by borrowing models and principles from many countries including United Kingdom and America.

The Constitution of India is not only a legal document but it also reflects social, political and economic perspectives of the Indian Society. It reflects India’s legacy of “diversity”. It has been said that Indian constitution reflects ideals of its freedom movement, however, few critics have argued that it does not truly incorporate our own ancient legal heritage and cultural values. No law can be “static” and therefore the Constitution of India has also been amended more than one hundred times. These amendments reflect political, social and economic developments since the year 1950. The Indian judiciary and particularly the Supreme Court of India has played an historic role as the guardian of people. It has been protecting not only basic ideals of the Constitution but also strengthened the same through progressive interpretations of the text of the Constitution. The judicial activism of the Supreme Court of India and its historic contributions has been recognized throughout the world and it gradually made it “as one of the strongest court in the world”.

Course content

1. Meaning of the constitution law and constitutionalism
2. Historical perspective of the Constitution of India
3. Salient features and characteristics of the Constitution of India
4. Scheme of the fundamental rights
5. The scheme of the Fundamental Duties and its legal status
6. The Directive Principles of State Policy – Its importance and implementation
7. Federal structure and distribution of legislative and financial powers between the Union and the States
8. Parliamentary Form of Government in India – The constitution powers and status of the President of India
9. Amendment of the Constitutional Powers and Procedure
10. The historical perspectives of the constitutional amendments in India
11. Emergency Provisions : National Emergency, President Rule, Financial Emergency
12. Local Self Government – Constitutional Scheme in India
13. Scheme of the Fundamental Right to Equality
14. Scheme of the Fundamental Right to certain Freedom under Article 19
15. Scope of the Right to Life and Personal Liberty under Article 21.



Universal Human Values - I

The objective of the course is four fold:

1. Sensitization of student towards self, family (relationship), society and nature.
2. Understanding (or developing clarity) of nature, society and larger systems, on the basis of human relationships and resolved individuals.
3. Strengthening of self reflection.
4. Development of commitment and courage to act.

At the end of the course, students are expected to become more aware of their surroundings, society, social problems and their sustainable solutions, while keeping human relationships and human nature in mind. They would have better critical ability. They would also become sensitive to their commitment towards what they believe in (humane values, humane relationships and humane society). It is hoped that they would be able to apply what they have learnt to their own self in different day-to-day settings in real life, at least a beginning would be made in this direction.

Environment Sc.: See under 6.2

Essence of Indian Knowledge Tradition (Attached separately)

Learning an Art Form (Music: vocal or instrumental, dance, painting, clay modeling, etc.): See under 2.1



Essence of Indian Knowledge Tradition Pt-I

भारतीय विद्या - 1

Course objective

The course aims at imparting basic principles of thought process, reasoning and inferencing. Sustainability is at the core of Indian Traditional knowledge Systems connecting society and nature. Holistic life style of yogic science and wisdom capsules in Sanskrit literature are also important in modern society with rapid technological advancements and societal disruptions. Part-I focuses on introduction to Indian Knowledge Systems, Indian perspective of modern scientific world-view, and basic principles of Yoga and holistic health care system.

Course Contents

- Basic structure of Indian Knowledge System: अ ादशिव4ा -8वेद,8उपवेद (आयुवद, धनवद, गनववेद, 3थापÆ आद) द्वेदाग (शबििीा, क¼, िान7ª, ाकरण, ¼ाशतष, छ) ¼ उपाङ्ग (धमिा™, मीमासा, पुराण, तकिा™)
- Modern Science and Indian Knowledge System
- Yoga and Holistic Health care
- Case studies

References

- *Knowledge traditions and practices of India, CBSE Publication*
- V. Sivaramakrishnan (Ed.), *Cultural Heritage of India-course material*, Bharatiya Vidya Bhavan, Mumbai. 5th Edition, 2014
- Swami Jitatmanand, *Modern Physics and Vedantharatiya Vidya Bhavan*
- Swami Jitatmanand, *Holistic Science and Vedantharatiya Vidya Bhavan*
- Fritzo Capra, *Tao of Physics*
- Fritzo Capra, *The Wave of life*
- VN Jha (Eng. Trans.), *Tarkasangraha of Annam Bhatta*, International Chinmay Foundation, Velliarnad, Arnakulam
- *Yoga Sutra of Patanjali*, Ramakrishna Mission, Kolkata
- GN Jha (Eng. Trans.), Ed. RN Jha, *Yoga-darshanam with Vyasa Bhashya*, Vidyanidhi Prakashan, Delhi 2016
- RN Jha, *Science of Consciousness Psychotherapy and Yoga Practices*, Vidyanidhi Prakashan, Delhi 2016
- P B Sharma (English translation), *Shodashang Hridayan*

Pedagogy: Problem based learning, group discussions, collaborative mini projects.

Outcome: Ability to understand, connect up and explain basics of Indian traditional knowledge in modern scientific perspective.



Essence of Indian Knowledge Tradition-Pt-2

भारतीय विद्यासागर - 2

Course objective

The course aims at imparting basic principles of thought process, reasoning and inferencing. Sustainability is at the core of Indian Traditional Knowledge Systems connecting society and nature. Holistic life style of yogic science and wisdom capsules in Sanskrit literature are also important in modern society with rapid technological advancements and societal disruptions. Part-2 focuses on Indian philosophical traditions, Indian linguistic Tradition, and Indian artistic tradition.

Course Contents

- Philosophical Tradition (सर्वद्विन्दु-आय, वैदिकशापक, सांख्य, योग, जैन, मीमांसा, वेदान्त, चर्वा)
- Indian Linguistic Tradition (Phonology, morphology, syntax and semantics)
- Indian Artistic Tradition - शाचकला, मूशातकला, वाङ्मयकला, उथापन, सगीत, नृत्यएवसाशाहल
- Case studies

References

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- *Panini Shiksha*, Motilal Banarasidas
- V.N. Jha, *Language, Thought and Reality*,
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- Krishna Chaitanya, *Arts of India*, Abhinav Publications, 1987
- R. Nagaswamy, *Foundations of Indian Art*, Tamil Arts Academy, 2002

Pedagogy: Problem based learning, group discussions, collaborative mini projects.

Outcome: Ability to understand, connect up and explain basics of Indian traditional knowledge in modern scientific perspective.



MODEL CURRICULUM

for

HUMANITIES AND SOCIAL SCIENCES INLCUDING MANAGEMENT COURSES

[January 2018]



ALL INDIA COUNCIL FOR TECHNICAL EDUCATION
Nelson Mandela Marg, Vasant Kunj, New Delhi 110 070
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ALL INDIA COUNCIL FOR TECHNICAL EDUCATION

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All India Council for Technical Education Model Curriculum for Humanities, Social Science including Management Courses

Under the new UG curriculum, courses related to Humanities and Social Science and Management have 12 credits.

1. Introduction

The world is changing rapidly today. Even though developments are taking place with greater production of physical facilities, conflict and strife are increasing in the individual and society. Environmental crisis in the form of climate change is putting life itself in danger.

In spite of achieving one's goals, the individual remains dissatisfied with jobs and positions that are intellectually and mentally unfulfilling, and wealth that breeds problems in family, chaos in society, and imbalance in nature. In fact, the nations and civilizations are increasingly at war.

It is believed that ideas in Humanities and Social Sciences can provide a new understanding, based on which one can move to overcome the current problems, both at the individual level as well as at the societal level.

2. Goals of the teaching of Humanities Courses

A rich set of courses and projects would help in making students into holistic human beings. Through these, the student would become aware of oneself and one's surroundings. One would gain a larger understanding of family, society, nation and the world.

The student would develop holistically as an individual in terms of art and culture, language and literature with sensitivity and awareness of one's surroundings. One would also understand and be aware of one's self, allowing one to understand one's role in larger scheme of things. Such an individual would be connected with and have an understanding of one's family, neighbourhood, society, nation and the world.

Thus, while the individual would be a global citizen of humanity, he would also be connected with and capable of acting locally. The individual would have an understanding of the past and the present, but would not be limited to it. One would also understand the future, what ought to be, and act to make it so.

This would give leadership qualities to the student, and would also enable one to become a better practitioner of engineering, and a better developer of technology.

3. Extension

The engineering colleges would connect with the local surroundings ranging from the city of institute and to the larger region around the institute. It can draw its projects from the region and the country. This would form a rich learning context for students as well as for its research. Hopefully, it would also contribute to the betterment of the surroundings.

4. Approach towards Humanities

Through various discussions emerged the approach to be adopted by the teaching humanities courses. The following was the broad agreement.



The institutes, through humanities courses, should encourage critical enquiry which cuts across disciplines. It should promote synergistic studies connecting humanities with science and technology. Such studies would generate interest among the students as well as throw new light on existing problems of mankind.

These courses should look for niche areas of work, which would connect it to society and to different disciplines. This would generate new ideas and help it reach excellence.

These courses should create platform for engineering students for creative combination of humanities with science and technology. Such a platform would create conditions for unearthing interdisciplinary insights and confluence of disciplines. Theory should help with practice, and practice should lead to theorizing.

This would create a new generation of people rooted in a new ethos. Engineers with such an ethos would be better connected to society, and are likely to do better engineering.

It would be extremely important to have a pedagogy which nurtures the confluence of technology with humanities. The courses would combine project work with insights from confluence of disciplines.

5. Disciplines and Themes

Courses could be organized around disciplines or around themes; examples of disciplines are sociology, economics, political science, psychology, philosophy etc. Examples of themes are

1. History & Civilization
2. Development Studies
3. Language, Literature, Linguistics & Cog. Sc.
4. Philosophy
5. Education
6. Culture

It is strongly felt that teaching of the early courses in HSS should be based on themes. The themes present a more real life picture to analyze for which one has to go to disciplinary theories. This sequence allows the student to think more holistically.

6. Proposed course structure

The courses can be arranged in following three categories.

Human Values Courses

This course discusses their role in their family. It, very briefly, touches issues related to their role in the society and the nature, which needs to be discussed at length in one more semester for which the foundation course named as “UHV-II: Universal Human Values: Understanding Harmony and ethical Human Conduct” is designed which may be covered in their I, II, III or IV semester.

During the Induction Program, students would get an initial exposure to human values through Universal Human Values–I. This exposure shall be augmented by this compulsory full semester foundation course.



Foundational humanities courses

The foundational humanities courses cover fundamental issues of the area of humanities. Exposure to these courses orients students towards the fundamentals of humanities in such a way that they develop sensibilities required for appreciating the humanities courses.

Following two courses are proposed under this category. Students may choose any one of these as foundational course.

HSMC (H-103): Development of societies

HSMC (H-104): Philosophy

Any of the course not done by the student in the foundational humanities course may be taken under elective category.

Elective humanities courses

After doing the above courses, students get prepared to appreciate the humanities courses and also through a foundation course they get prepared for a specific area of humanities. Now students can take up elective humanities courses for which the foundation courses serves as pre-requisite.

Following elective humanities courses are proposed under this category. Students may choose any one of these or the other Foundational Course not taken by them.

A. Humanities(HU) Courses

HSMC (H-103/H-104) :	Foundational Course in Humanities (Development of Societies/Philosophy)
HSMC (HED-314) :	Education, Technology and Society
HSMC (HHI- 305) :	History of Science and Technology in India
HSMC (HPH-304) :	Nyaya Logic Epistemology
HSMC (HPL-307) :	Political and Economic Thought for a Humane Society
HSMC (HPL-312) :	State, Nation Building and Politics in India
HSMC (HPY-301) :	Psychological Process
HSMC (HPY-302) :	Positive Psychology
HSMC (HPY-303) :	Application of Psychology
HSMC (HSL-308) :	Sociology, Society and Culture
HSMC (HSL-309) :	Epochal Shift
HSMC (HVE-310) :	Values and Ethics
HSMC (HVE-311) :	Ethics and Holistic Life
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HSMC (HPL-306) :	Contemporary India in Globalized Era: Challenges of Democracy and Development
HSMC (HCL-319) :	Making Indian Culture: Epistemic Traditions, Literature and Performative Arts



B. Language Courses

HSMC (LLG-305)	:	Sanskrit Bhasa
HSMC (LLG-306)	:	Language and Communication
HSMC (LLN-307)	:	Language and Linguistics
HSMC (LLT-301)	:	Understanding Society and Culture through Literature
HSMC (LLT-302)	:	Fundamentals of Linguistics
HSMC (LLT-303)	:	Elements of Literature
HSMC (LLT-308)	:	Humanities and Multiple Dimensions of Ecology
HSMC (LMD-304)	:	Film Appreciation

Management courses

It is also recommended that the following management courses may also run for the undergraduate students.

HSMC (MIM-472)	:	Introduction to Industrial Management
HSMC (MIM-480)	:	Macro Economics
HSMC (MIM-578)	:	Quantitative Methods for Decision Making
HSMC (MIM-475)	:	Economics for Engineers
HSMC (MME-301)	:	Fundamentals of Management for Engineers
HSMC (MME-302)	:	Project Management and Entrepreneurship
HSMC (MME-303)	:	Law and Engineering
HSMC (MME-304)	:	Understanding Interpersonal Dynamics

Curricular Structure

Semester	L-T-P-C	Course No. & Title
1	2-1-0-3	L-101 Basic English
2or 3	2-1-0-3	H-103/H-104 Foundation Course in Humanities (Development of Societies/Philosophy)
4	2-1-0-3	UHV-II-(H-102) Universal Human Values – II: Understanding Harmony and Ethical Human Conduct
5-8	2-1-0-3	Humanities elective

It is also recommended that out of total elective slots, the student be permitted to take additional HSS electives (beyond 12 credits). Thus, he/she may substitute 6 additional credits as HSS credits out of total SC/Engg. electives.

7. Details on Themes

Theme: History and Civilization

This theme is such that it can integrate with many different branches of humanities. The major challenge is to select highly competent teachers.



Pedagogy

Having the right pedagogy is crucial to this theme. Some important points are given below:

- a) The pedagogy should be project oriented and thematic, rather than being a chronological description of events.
- b) Face and discuss controversies.
- c) Visit sites and museums. However, for these to be meaningful, students must study the related reference material prior to the visit.
- d) Visit craftsmen and other traditional communities.
- e) Use visuals -- images, films, literature, theatre -- wherever appropriate.
- f) Have research projects to create larger picture of times and society. The following can be some of the projects:
 - Choose one monument -- do in-depth research
 - Choose one festival -- connect with communities and mythology
 - Choose one inscription -- connect with historical times
 - Choose one personality -- study the times, and how the individual coped with difficulties. It can be very inspiring. Example: Social leaders, scientists, authors, freedom fighters, and visionaries such as Mahamana Madan Mohan Malviya.
 - Choose one city -- what makes the city alive
 - Choose family histories
 - Choose local oral history (e.g. legends, ballads)
- g) Encourage debates
 - Promote different approaches
 - Different methods of history
 - Understand limits of history

Theme: Development Studies

Development Studies deals with the study of development goals, structures, processes, and its impact. It uses economic, social and political science theories to understand development. A historical study adds depth and vitality to the understanding.

Main Issues

The main outcomes of the group are summarized below:

- a) Development studies provide a natural link between engineering and humanities.
- b) Development is not just materialistic, larger view of human development should be presented.
- c) Sustainable development. The student should understand the inter-dependence and co-existence in nature.
- d) Distribution of fruits of development in an equitable manner.
- e) Role of state in protecting vulnerable communities. Contemporary development involves a lot of violence. Understanding the violence and ways to avoid it.



- f) Process of development should be participatory and democratic. Our role in facilitating it.
- g) Comparative studies of alternative models of development.
- h) Indices of development besides GDP, e.g., GNH, quality of life, etc.
- i) Development of the self along with physical development. Student should be able to understand the difference between necessity and greed.
- j) Ethics and values in development. Ethics of environment.
- k) Public policy informed with environment and ethics.

Relating to Practise

The course should relate the students with actual situation prevailing today. Accordingly, the following should be done:

- a) Interact with local communities
- b) Include social work with under-privileged as a part of curriculum (e.g., kashiutkarsh)
- c) Practice should influence theory making
- d) Impact of public welfare schemes
 - Study implementation of a government scheme for the under privileged
 - Intervene in one of the government schemesEx. Get ration card to one deprived family under BPL.
- e) Technical evaluation of a govt. developmental project, e.g., watershed in a village.
- f) Local cottage industry and agricultural practices. Role of engineering and specialized knowledge.
- g) Evaluation of technology in the context of its application. Social impact of the technology.
Environmental impact of technology. Evaluation from a holistic perspective.

Theme: Language, Literature, Linguistics & Cog. Sc.

The theme of language should be developed as an independent area not limited to and not focussed only on remedial English teaching. If necessary, a research unit should be established first, so that the research and advanced teaching areas of the department can be developed. It will help attract the right kind of faculty, which will ultimately benefit the remedial English classes too.

Convergence and Enabling Platforms

The theme has the potential to bring together many different aspects of humanities. The following are the domains of convergence, and the platforms to enable this bringing together. They are to be supported by explorations in niche areas and case studies.

- a) Domains of Convergence Studies -- Creative writing, critical analysis, comparative literature, educational linguistics, translation as a method for critical study of a text, role of machine translation, translation to trans-creation
- b) Enabling Platforms -- Combine forms of media (audio, video, pictures) with forms of expression (literature, art, music, dance, science, technology)



- c) Niche Areas --Heritage languages, heritage cities, socio-spiritual art forms, ethics and human values, creative technical writing, translation
- d) Unique Case Studies -- Narratives, multi-lingual classics

Discussion

- a) Language uses categories which influence the thinking of people. So work should be done on categories used. One could look at words across languages which are frequently translated, but give the wrong meaning to the reader unless one reads it carefully. For example, dharma and religion are two different things, but they have gotten mixed up due to improper translation. As a result, somebody reading a text can completely misunderstand things, or a listener can misunderstand what is being said.

Identifying words across two languages (say, between English vs Sanskrit/Hindi) and finding out what are the similarities in meaning and what are the differences would be helpful. In view of this, courses in Literature, Indian Philosophy etc. may also be taught in Hindi or other Indian languages.

- b) Word “development” is also frequently misunderstood, and influences our thinking. Development should really mean establishment of a civilized and humanistic society.
- c) Linguistics and Cognition can play a role in bringing precision or exactness in expression and thought. Through it one can study language as a semiotic and social system. Such a study can act as a bridge between the sciences and the humanities.
- d) Computational Linguistics and Cognitive Science can be used in teaching language as well as in machine translation.
- e) Courses based on our heritage can be designed pertaining to, for example, from Indian mathematics, astronomy, culture, etc. Our heritage can also contribute to ethics, linguistics, etc.

Theme: Philosophy

Philosophy traditionally has played two roles:

- a) It builds systems around profound, novel but scattered ideas. For example, Nagarjuna, Dinnaga to Buddha; Adi Shankara to Upanishads and Vedas; Plato to Socrates; St. Augustine and St. Aquinas to Christ.
- b) It plays the role of rigorously scrutinising the internal structure, rigor, nature and validity of argumentation and thesis.

The curriculum can consider incorporating both the above.

The group unanimously felt that there is a need to introduce an orientation course for humanities courses in general and for philosophy courses in particular. The underlying reason for this is that



while students till 10th class have a natural familiarity with humanities, this however gets discontinued subsequently. There are two suggestions about the nature of courses:

Those which are more like extensions to science and technology, like logic, philosophy of science. These are like the balcony from where the students of technology, while continuing to remain in the same building, can see those outside the building. Some would also be inclined to come out and take a walk outside.

The other kinds of courses are ethics and values, different ways of knowing, self and society, theory and practice, self and transcendence. These would help the student in identifying one's goals and purpose and working out one's program of action in life.

In this context, it is suggested that courses should avoid burdening the students through loading information. They also should seek to induce further interest in the subject thus avoiding the student relapsing into complacency.

There are varied suggestions about what should be included in a course. It should be theme based; should consist of both Indian and Western (problem of sequencing); comparative courses; application components; relevance, interactive and not isolationist.

There was consensus regarding the need to bridge the gap between theory and practice by making the courses interactive. For instance, it is suggested that reading Sankara and practising his philosophy or studying those that practice philosophy; social critique of philosophical practices; Advaita and the practice of untouchability; modernity excluding emotions and there by denigrating women who are equated with emotion.

Along with projects, there is a need to have more illustrations that would invite students into the subject.

There was a suggestion to extract philosophy from real life practices of craftsmen and women, from society thus enriching the subject with new ideas. This also can help in bridging the theory practice gap in an interactive manner.

Courses that relate philosophy to literature, culture, society and lived experience can be considered. This is in addition to training students in already available philosophical systems. Instead of only theory or only practical courses attempt can be made to combine both theory and practice. Madhyastha Darshan has figured in this context in the discussions.

There was a suggestion to maintain meta-level status of philosophy. Interestingly this suggestion came from an engineering faculty.

Courses can be light providing student's scope to explore. There can be courses that are intense textual studies.

Need to translate ideas from classical texts, and retain those original terms that are difficult to translate.



Ask students to do term papers, for example, writing biographical details of founders, sustainers, transmitters, modifiers, rewriters; translating monographs of less known philosophers such as K. C. Bhattacharyas, Daya Krishna, Gopinath Bhattacharya; comparative study of philosophical system such as Madhyastha Darshan.

Teacher training program would be essential while designing such a program.

Theme: Education

Education is what the older generation offers to the younger generation. In engineering colleges, education is mostly limited to technical education. Humanities department would make it humanistic and socially purposeful. Value education or human values in education would develop the awareness of the student.

Purpose of education is to develop understanding and awareness of the self, the larger human purpose, and one's role in society or human conduct. It means developing the following:

- Understanding society, nature and human role (samajhdari)
 - Personal integrity (imandari))
 - Social responsibility (jimmedari)
 - Contributing my bit (bhaagidaari)
- a) Jigyasa (deep desire to know) comes from the person and cannot be imposed. Source of inspiration is always a living person, therefore, teacher has to become worthy of emulation. Teacher would have to practise what he preaches.
 - b) How do you re-orient an incoming student? Can it happen only in the classroom? It can happen in three possible ways:
 - Meet inspirational people from social, spiritual, political domains
 - Living and dialoguing with such people
 - Reading relevant texts
 - c) During discussion it was said that the student should learn how to learn, and that can happen when creative inquisitive mind is created.
 - d) Include a study of the ancient model of education. Distinguish between inner and outer world. Have five Kosha model of education.
 - e) Getting teachers is the major concern. Be careful in hiring. Also plan to have visiting scholars for varying durations.
 - f) Have a teach-the-teachers program in place.
 - g) Our school education system can be studied, particular in relation to policy on education. Is it able to fulfil its responsibilities and expectations?



As student projects and term papers, case studies can be carried out on the following:

- Alternate models of education including their philosophy and pedagogy
- Field study of government schools
- Study of private schools
- Formal education alienating students from their families and hand labour
- Formal education affecting the view of students towards themselves
- Education and equity

Theme: Culture

What is Culture?

Culture is a holistic streamline, over time, assimilating and consolidating a flow of themes, in a circle (vritta):

- History and civilization: search for roots
- Language, literature, and various expressions
- Cognitive mechanisms: individual (vyasti) and collective (samasti)
- Philosophy as a way of life and education
- Various development processes and evolution

Courses

There should be (a) core foundation courses (urdhha mulam), (b) the making of first set of electives, and (c) later electives and inter-disciplinary courses. They should ground centric and people centric actions. Pilots can be run on place-folk-work ethos (addwa sakham).

a) First foundations: Explorative and reflective processes

These cover from the roots to relatively open-ended journey. For example, - Six Vedangas and their ramifications: Indian arts, music, dance, performing arts, shape grammar, geometry, Indian built environment sciences

- Canonical folk-based population-based studies
- Event or personality driven tales: patterns, myths, imageries, icons Classes could be based on lived practices from
- Indian agro-economy based culture
- Culture driven home-stead, cottage-steam and farm-stead drivensustainable socio-economic nutrition (food) systems
- Indian river systems
- Indian settlement systems

They would emphasize a return to the local culture, already there is too much of global mono-culture.



b) First Set of Electives: Explorative to Creative Processes

The courses could pilot on:

- Indian theatre and the global culture
- Indian music and the global culture
- Indian cuisines and international markets
- Indian ayurveda and world medicine
- Indian traditional knowledge systems and world creative economy

c) Later Electives: New Knowledge Systems, Exploratory Leaps

- Building of e-repositories, which will be useful for future research and would be useful to expand future pedagogy

Culture studies would intersect with other themes such as History and Civilization, Education, Philosophy, etc.

From Hierarchy to Holarchy

The symbiotic themes would be:

- Shastra (seed) and parampara (time)
 - Living traditions rooted in the past
 - Tradition of pilgrimage, integrated with exploratory studies
 - Contemporary networking (centripetal nature) of Indian culture
 - Reaching the foundations of Indian culture
 - Embedding and awareness
-



Development of Societies **Course code: HSMC (H-103)**

Credits: 2-1-0-8

1. OBJECTIVE:

This is one of the foundation courses of Humanities (in Foundation Area 1). It is envisaged that this course will provide a natural link between engineering and humanities with an emphasis that Development is not just materialistic, larger view of all round human development should also be considered. Importance of sustainable development, inter-dependence and co-existence in nature should be realised through this course. It is to gain an understanding of alternative models of development.

2. COURSE TOPICS:

Unit I: Social Development

(5 hours)

1. Concepts behind the origin of Family, Clan and Society
2. Different Social Systems
3. Relation between Human being and Society
4. Comparative studies on different models of Social Structures and their evolution

Unit II: Political Development

(3 hours)

1. Ideas of Political Systems as learnt from History
2. Different models of Governing system and their comparative study

Unit III: Economic Development

(18 hours)

1. Birth of Capitalism, Socialism, Marxism
2. Concept of development in pre-British, British and post British period- Barter, Jajmani
3. Idea of development in current context.
4. E. F. Schumacher's idea of development, Buddhist economics.

Gandhian idea of development. Swaraj and Decentralization.

3. READINGS

TEXTBOOK::

*REFERENCE BOOKS::

4. OTHER SESSIONS

*TUTORIALS::

*LABORATORY::

*PROJECT:: Possible projects in this course could be

- a) Interact with local communities and understand their issues.
- b) Study local cottage industry and agricultural practices. Role of engineering and specialized knowledge.
- c) Evaluation of technology in the context of its application. Social impact of technology. Environmental impact of technology. Evaluation from a holistic perspective.

5. ASSESSMENT (indicative only)

HA:: [xx% GRADE]

QUIZZES-HA:: [xx% GRADE]

PERIODICAL EXAMS:: [xx% GRADE]

*PROJECT:: [xx% GRADE]

FINAL EXAM:: [xx% GRADE]



PHILOSOPHY

Course code: HSMC (H-104)

Credits: 2-1-0-8

1. Objective:

Even though developments are taking place with greater production of physical facilities, conflict and strife are increasing in the individual and society. Environmental crisis in the form of climate change is putting life itself in danger.

In spite of achieving one's goals, the individual remains dissatisfied with jobs and positions that are intellectually and mentally unfulfilling, and wealth that breeds problems in family, chaos in society, and imbalance in nature. In fact, the nations and civilizations are increasingly at war.

It is believed that ideas in Humanities and Social Sciences can provide a new understanding, based on which one can move to overcome the current problems, both at the individual level as well as at the societal level.

It was felt that there is a need to introduce an orientation course for humanities courses in general and for philosophy courses in particular. The underlying reason for this is that while students till 10th class have a natural familiarity with humanities, this however gets discontinued subsequently.

This course is expected to relate philosophy to literature, culture, society and lived experience can be considered. This is in addition to training students in already available philosophical systems. Instead of only theory or only practical courses attempt can be made to combine both theory and practice.

This course is expected to bridge the gap between theory and practice by making the courses interactive. Along with projects, this course will have more illustrations that would invite students into the subject.

2. COURSE TOPICS:

Unit 1:

The difference between knowledge (Vidya) and Ignorance (Avidya):

- a. Upanishads;
- b. Six systems orthodox and Heterodox Schools of Indian Philosophy.
- c. Greek Philosophy:

Unit 2:

Origin of the Universe:

- Nasidiya Sukta: "Who really knows?"
- Brhadaranyaka Upanishad; Chandogya Upanishad: Non-self, Self, real and unreal.
- Taittiriya Upanishad: Siksha Valli.
- Plato's Symposium: Lack as the source of desire and knowledge.
- Socratic method of knowledge as discovery.
- Language: Word as root of knowledge (Bhartrahari's Vakyapadiyam)
- Fourteen Knowledge basis as a sources of Vidya: Four Vedas; Six auxiliary sciences (Vedangas); Purana, Nyaya, Mimamsa and Dharma Sastras.



Unit 3:

Knowledge as Power: Francis Bacon. Knowledge as both power and self-realization in Bagavad Gita.

Unit 4:

Knowledge as oppression: M. Foucault. Discrimination between *Rtam* and *Satyam* in Indian Philosophy.

Unit 5:

Knowledge as invention: Modern definition of creativity; scientific activity in the claim that science invents new things at least through technology.

Unit 6:

Knowledge about the self, transcendental self; knowledge about society, polity and nature.

Unit 7:

Knowledge about moral and ethics codes.

Unit 8:

Tools of acquiring knowledge: *Tantrayuktis*, a system of inquiry (Caraka, Sushruta, Kautilya, Vyasa)

3. READINGS

1. Copleston, Frederick, History of Philosophy, Vol. 1. Great Britain: Continuum.
2. Hiriyanna, M. Outlines of Indian Philosophy, Motilal Banarsidass Publishers; Fifth Reprint edition (2009)
3. Sathaye, Avinash, Translation of Nasadiya Sukta
4. Ralph T. H. Griffith. The Hymns of the R̥gveda. Motilal Banarsidass: Delhi: 1973.
5. Raju, P. T. Structural Depths of Indian Thought, Albany: State University of New York Press.
6. Plato, Symposium, Hamilton Press.
7. Kautilya Artha Sastra. Penguin Books, New Delhi.
8. Bacon, Nova Orgum
9. Arnold, Edwin. The Song Celestial.
10. Foucault, Knowledge/Power.
11. Wildon, Anthony, System of Structure.
12. Lele, W.K. The Doctrine of Tantrayukti. Varanasi: Chowkamba Series.
13. Dasgupta, S. N. History of Indian Philosophy, Motilal Banasidas, Delhi.
14. Passmore, John, Hundred Years of Philosophy, Penguin.

4. OTHER SESSIONS:

Mode of Conduct

5. ASSESSMENT (indicative only):

Ask students to do term papers, for example, writing biographical details of founders, sustainers, transmitters, modifiers, rewriters; translating monographs of less known philosophers such as K. C. Bhattacharyas, Daya Krishna, Gopinath Bhattacharya; comparative study of philosophical system such as Madhyastha Darshan.

6. OUTCOME OF THE COURSE:

Students will develop strong natural familiarity with humanities along with right understanding enabling them to eliminate conflict and strife in the individual and society. Students shall be able to relate philosophy to literature, culture, society and lived experience can be considered.



EDUCATION, TECHNOLOGY AND SOCIETY

Course code: HSMC (HED-314)

1. OBJECTIVES:

The goal of the proposed course is to enable students:

- i. To explore the various ways in which technology has and may in future affect not only the mode of delivery of education but also the very nature of education.
- ii. To understand the requirement of education
 - a. for becoming an effective member of the society
 - b. to fulfill the potential of a learner to the fullest without too much thought of an individual's responsibility towards the contemporary society.

2. COURSE TOPICS:

Unit 1: Necessity of education for human life, Impact of education on society

Unit 2: Nature and scope of education (Gurukul to ICT driven), Emotional intelligence Domains of learning, Approaches to learning, Learning outcomes

Unit 3: Role of education in technology advancement.

Unit 4: Technology and society; management of technology; technology transfer

Unit 5: Ethical and value implications of education and technology on individual and society

3. COURSE OUTCOME:

On successful completion of this course, the students will be able to integrate their technical education for betterment of society as well motivates them to lead a good human life.

4. REFERENCE BOOKS:

- Education and Social order by Bertrand Russel
 - Theories of learning by Bower and Hilgard
 - Technology and Society by Jan L Harrington
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HISTORY OF SCIENCE AND TECHNOLOGY IN INDIA

Course Code: HSMC (HHI-305)

Unit-I

CONCEPTS AND PERSPECTIVES

- Meaning of History
- Objectivity, Determinism, Relativism, Causation, Generalization in History; Moral judgment in history
- Extent of subjectivity, contrast with physical sciences, interpretation and speculation, causation versus evidence, concept of historical inevitability, Historical Positivism.
- Science and Technology-Meaning, Scope and Importance, Interaction of science, technology & society, Sources of history on science and technology in India.

Unit-II

HISTORIOGRAPHY OF SCIENCE AND TECHNOLOGY IN INDIA

- Introduction to the works of D.D. Kosambi, Dharmapal, Debiprasad Chattopadhyay, Rehman, S. Irfan Habib, Deepak Kumar, Dhruv Raina, and others.

Unit-III

SCIENCE AND TECHNOLOGY IN ANCIENT INDIA

- Technology in pre-historic period
- Beginning of agriculture and its impact on technology
- Science and Technology during Vedic and Later Vedic times
- Science and technology from 1st century AD to C-1200.

Unit-IV

SCIENCE AND TECHNOLOGY IN MEDIEVAL INDIA

- Legacy of technology in Medieval India, Interactions with Arabs
- Development in medical knowledge, interaction between Unani and Ayurveda and alchemy
- Astronomy and Mathematics: interaction with Arabic Sciences
- Science and Technology on the eve of British conquest

Unit-V

SCIENCE AND TECHNOLOGY IN COLONIAL INDIA

- Science and the Empire
- Indian response to Western Science
- Growth of techno-scientific institutions

Unit-VI

SCIENCE AND TECHNOLOGY IN A POST-INDEPENDENT INDIA

- Science, Technology and Development discourse
 - Shaping of the Science and Technology Policy
 - Developments in the field of Science and Technology
 - Science and technology in globalizing India
 - Social implications of new technologies like the Information Technology and Biotechnology
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NYĀYA LOGIC AND EPISTEMOLOGY

Course Code-HSMC (HPH-304)

1. Metaphysical, Epistemological and Rhetorical context of Nyaya Logic – The metaphysics of Padarthas, The theory of Prama and pramana.
2. The nature of anumana as pramana. The process of Svarthanumana, Anumana and Anumiti, The nature of Pararthanumana. The five Avayavas.
3. The important terms in anumana – Paksa, Sapaksa, Vipaksa, Vyapti, Avinabhava, Drstanta, Upadhi.
4. The classification of Anumana – Purvavat, Seshavat, Samanyatodrsta, Kevalanvayi, Kevalanvatireki, Anvayavyatireki(Nyaya), Svabhavanumana, Karyanumana(Buddhism), The three kinds of Hetu : Svabhava, Karya, Anuplabdhi.
5. Five characteristics of Hetu (Nyaya), Five Hetvabhasas (Nyaya).
6. The inductive element of Anumana – The way of knowing Vyapti: Bhuyodrasana (Mimamsa), Samanyalaksana Pratyasatti, Tarka (Nyaya); Tarka as Pramana (Jainism) Carvaka Criticism of Anumana.
7. Nature of Vyapti. Purvapaksa and Siddhantapaksa Vyapti.
8. Other pramanas comparable with Anumana; Sabda Upamana, Anupalabdhi, Arthapatti. Their reducibility to Anumana.

BOOKS FOR READING:

1. D. N. Datta – Six ways of Knowing, Calcutta, 1960.
 2. Athalye, Bodas – Tarkasamgraha of Annambhatta, Pune.
 3. P. P. Gokhale – Inference and fallacies discussed in ancient Indian Logic.
 4. Sachchidanand Mishra- Nyāya Darshan mein Anuman
 5. S. C. Chatterjee--The Nyāya Theory of Knowledge
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POLITICAL AND ECONOMIC THOUGHT FOR A HUMANE SOCIETY

Course Code: HSMC (HPL-307)

Credits: 3-0-0-9

Pre-Requisite: None. (Desirable: Universal Human Values-II, Universal Human Values=II)

OBJECTIVES:

This course will begin with a short overview of human needs and desires and how different political-economic systems try to fulfill them. In the process, we will end with a critique of different systems and their implementations in the past, with possible future directions.

COURSE TOPICS:

Considerations for humane society, holistic thought, human being's desires, harmony in self, harmony in relationships, society, and nature, societal systems. **(9 lectures, 1 hour each)**
(Refs: A Nagaraj, M K Gandhi, JC Kumarappa)

Capitalism – Free markets, demand-supply, perfect competition, laissez-faire, monopolies, imperialism. Liberal democracy. **(5 lectures)**
(Refs: Adam Smith, J S Mill)

Fascism and totalitarianism. World war I and II. Cold war. **(2 lectures)**

Communism – Mode of production, theory of labour, surplus value, class struggle, dialectical materialism, historical materialism, Russian and Chinese models.
(Refs: Marx, Lenin, Mao, M N Roy) **(5 lectures)**

Welfare state. Relation with human desires. Empowered human beings, satisfaction. **(3 lectures)**

Gandhian thought. Swaraj, Decentralized economy & polity, Community. Control over one's lives. Relationship with nature. **(6 lectures)**
(Refs: M K Gandhi, Schumacher, Kumarappa)

Essential elements of Indian civilization. **(3 lectures)**
(Refs: Pt Sundarlal, R C Mazumdar, Dharampal)

Technology as driver of society, Role of education in shaping of society. Future directions. **(4 lectures)** (Refs: Nandkishore Acharya, David Dixon, Levis Mumford)

Conclusion (2 lectures)

Total lectures: 39

Preferred Textbooks: See Reference Books

Reference Books: Authors mentioned along with topics above. Detailed reading list will be provided.

GRADING:

Mid sems	30
End sem	20
Home Assign	10
Term paper	40

OUTCOME:

The students will get an understanding of how societies are shaped by philosophy, political and economic system, how they relate to fulfilling human goals & desires with some case studies of how different attempts have been made in the past and how they have fared.



STATE, NATIONBUILDING AND POLITICS IN INDIA

Course Code: HSMC (HPL-312)

OBJECTIVE:

The objective of the course is to provide an understanding of the state, how it works through its main organs, primacy of politics and political process, the concept of sovereignty and its changing contours in a globalized world. In the light of this, an attempt will be made to acquaint the students with the main development and legacies of national movement and constitutional development in India, reasons for adopting a Parliamentary-federal system, the broad philosophy of the Constitution of India and the changing nature of Indian Political System. Challenges/ problems and issues concerning national integration and nation-building will also be discussed in the contemporary context with the aim of developing a future vision for a better India.

TOPICS:

- Understanding the need and role of State and politics.
- Development of Nation-State, sovereignty, sovereignty in a globalized world.
- Organs of State – Executive, Legislature, Judiciary. Separation of powers, forms of government-unitary-federal, Presidential-Parliamentary,
- The idea of India.
- 1857 and the national awakening.
- 1885 Indian National Congress and development of national movement – its legacies.
- Constitution making and the Constitution of India.
- Goals, objective and philosophy.
- Why a federal system?
- National integration and nation-building.
- Challenges of nation-building – State against democracy (Kothari)
- New social movements.
- The changing nature of Indian Political System, the future scenario.
- What can we do?

OUTCOME OF THE COURSE:

It is expected that this course will make students aware of the theoretical aspect of the state, its organs, its operationalization aspect, the background and philosophy behind the founding of the present political system, broad streams and challenges of national integration and nation-building in India. It will equip the students with the real understanding of our political system/ process in correct perspective and make them sit up and think for devising ways for better participation in the system with a view to making the governance and delivery system better for the common man who is often left unheard and unattended in our democratic setup besides generating a lot of dissatisfaction and difficulties for the system.

SUGGESTED READING:

- i. Sunil Khilnani, The Idea of India. Penguin India Ltd., New Delhi.
- ii. Madhav Khosla, The Indian Constitution, Oxford University Press. New Delhi, 2012.
- iii. Brij Kishore Sharma, Introduction to the Indian Constitution, PHI, New Delhi, latest edition.
- iv. Sumantra Bose, Transforming India: Challenges to the World's Largest Democracy, Picador India, 2013.
- v. Atul Kohli, Democracy and Discontent: India's Growing Crisis of Governability, Cambridge University Press, Cambridge, U. K., 1991.
- vi. M. P. Singh and Rekha Saxena, Indian Politics: Contemporary Issues and Concerns, PHI, New Delhi, 2008, latest edition.
- vii. Rajni Kothari, Rethinking Democracy, Orient Longman, New Delhi, 2005.



PSYCHOLOGICAL PROCESSES

Course code: HSMC (HPY-301)

Credits: 2-1-0-8

1. OBJECTIVES:

The objectives of this course are to make students:

- 1) aware of the basic principles of psychology for the behaviour of people,
- 2) aware that psychology is both a theoretical and an applied science, and
- 3) understand how the knowledge gained from this course can be used in their own personal and professional work life.

2. COURSE TOPICS:

Unit 1: Introduction: Psychology as a scientific study of behaviour. Biological and socio-cultural bases of behaviour. Fields of psychology.

Unit 2: Sensory and perceptual processes: Sensation, attention and perception.

Unit 3: Cognition and Affect: Learning and memory. Emotion and motivation

Unit 4: Thinking, problem solving and decision making

Unit 5: Personality and intelligence

Required Text:

Zimbardo, P. G. (2013). Psychology and Life (20th Ed.). New York: Pearson Education.

Readings:

1. Baron, R. A. (2006). Psychology (5th Ed.). New Delhi: Pearson Education.
 2. Coon, D., & Mitterer, J. O. (2007). Introduction to Psychology: Gateway to mind and behaviour. New Delhi: Cengage.
 3. Feldman, R. S. (2013). Psychology and your life (2nd Ed.). New York: McGraw Hill.
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POSITIVE PSYCHOLOGY
Course Code: HSMC (HPY-302)

OBJECTIVE:

Understanding psychology can improve your well-being and success both at work and in your personal life. Positive psychology is the growing branch of psychology that focuses on strengths, positive states and happiness. This Positive Psychology course will have a particular emphasis on applying positive psychology in your personal and working life.

COURSE OUTLINE:

1. Positive Psychology: An Introduction
2. Happiness
3. Flow
4. Subjective Well-being
5. Hope
6. Optimism
7. Positive Illusions and Playfulness
8. Creativity, Giftedness & Industry
9. Judgment, Wisdom & Fairness
10. Emotional Intelligence & Prudence
11. Spirituality
12. Love & Kindness
13. Gratitude & Zest
14. Modesty & Forgiveness
15. Altruism & Empathy & Social Intelligence
16. Positive Psychology at Work – Leadership, & Teamwork
17. Curiosity, Self-Regulation & Positive Youth Development

Number of student allowed to enrol for this course: 30 (Maximum)



APPLICATIONS OF PSYCHOLOGY IN EVERYDAY LIFE
Course code: HSMC (HPY-303)

Credits: 2-1-0-8

1. OBJECTIVES:

The objectives of this course are to make students:

- 1) aware of the different applications of psychology to everyday issues of life,
- 2) aware of the different social issues, workplace issues, and behavioural issues, and
- 3) understand how the knowledge gained from this course can be used in their own personal and professional work life.

2. COURSE TOPICS:

- 2.1 Unit 1:** Introduction: Nature and fields. (6)
- 2.2 Unit 2:** Psychology in industries and organizations: Job analysis; fatigue and accidents; consumer behavior. (8)
- 2.3 Unit 3:** Psychology and mental health: Abnormality, symptoms and causes psychological disorders.(10)
- 2.4 Unit 4:** Psychology and Counseling: Need of Counseling, Counselor and the Counselee, Counseling Process, Areas of Counseling. (6)
- 2.5 Unit 5:** Psychology and social behavior: Group, group dynamics, teambuilding, Prejudice and stereotypes; Effective Communication, conflict and negotiation. (10)

Text

1. Schultz, D. & Schultz, S.E. (2009). Psychology and Work Today (10th ed.). New Jersey:Pearson/Prentice Hall.
 2. Butcher, J. N., Mineka, S., & Hooley, J. M. (2010). Abnormal psychology (14th ed.). New York: Pearson
 3. Gladding, S. T. (2014). Counselling: A comprehensive profession. New Delhi: Pearson Education
 4. Aronson, E., Wilson, T. D., & Akert, R. M. (2010). Social Psychology (7th Ed.). Upper Saddle River, NJ: Prentice Hall.
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SOCIOLOGY, SOCIETY AND CULTURE

Course code: HSMC (HSL-308)

Credits: 2-1-0-8

1. OBJECTIVE:

This is one of the foundation course of Humanities (in Foundation Area 1). It strengthens the interest of the student in social issues and demonstrate both the process and challenge of scientific observation and analysis of social behaviour and social data. It focuses on the understanding of basic concepts and descriptive materials of sociology which is considered a tool for identifying the process of idea and a scientific approach for continuing social observation and analysis.

2. COUSE TOPICS:

Unit I: Sociology as a Science

(7 hours)

1. Sociology and common Sense
2. Sociology and current affairs
3. Sociology as a science
4. Logic in sociological inquiry
5. Sociology of action
6. The field and relevance of sociology
7. Positivism

Unit II: Society and Culture

(12 hours)

1. Culture and society
2. The structure of culture
 - Cultural Traits and complexes
 - Subcultures and counter cultures
 - Cultural integration
 - Cultural relativism
 - Real and Ideal culture
 - Ethnocentrism
 - Xenocentrism
 - Cultural lag

Unit III: Social Institutions

(17 hours)

1. The concept of varna.
2. The Caste system:
 - Origin and characteristics (of caste) as a system
 - Hierarchy based on birth
 - Religious sanctions on social participation



- Caste and subcaste
 - Caste conflicts
 - Caste councils
 - An appraisal of caste system
 - Prospects of caste in modern India
3. The Class system:
- What is social class?
 - Development of class
 - Self-identification and class consciousness
 - Class in itself and class for itself
 - Class having blue collar status and white collar status
 - Industrial class
 - Significance of social class
 - The future of social classes: From Proletariat to status seekers

Unit IV: Environment and Ecology (10 hours)

1. Conceptualising environment
2. Forest, ecology and society
3. Common Property Resources and its management
4. Significance of forest and environment in modern life
5. Environmental movement with reference to forest and water management

Unit V: Issues of modernity (14 hours)

1. Concept of modernity
2. Tradition Vs Modernity
3. Globalization
 - Is globalization new and real?
 - Has globalization weakened the state?
 - Has globalization led to cultural homogenisation?
 - Does globalization lead to a clash of cultures?

3. READINGS:

Reference Books:

- Gisbert, P. (2011), Fundamental of Sociology, Orient Blackswan Private Ltd.
- Horton, Paul B. and Hunt, Chester L. (Sixth edition), Sociology, Mc Graw Hill Book Company.
- Haralambos, M. and Heald, R.M. (26th impression, 2004), Sociology: Themes and Perspectives, Oxford University Press, New Delhi.
- Betteille, Andre (2014), sociology: essays on Approach & Method, Oxford University Press, New Delhi.



- Ahuja, Ram (2006), Indian Social System, Rawat Publications, New Delhi.
- Guha, Ramchandra (1994), Social Ecology, Oxford University Press, New Delhi.
- Sundar Nandini, Jeffery Roger and Thin, Neil (2001) Branching out Joint Forest Management in India, Oxford University Press, New Delhi.
- Dunlap, Riley E. and Micelson, William (2008), Handbook of Environmental Sociology, Rawat Publications, New Delhi.
- Moore, Francis (2003), Environment and Society, Dominant Publishers, New Delhi.
- Boman, Z. (1989), Modernity and Holocaust, Cambridge Polity Press.
- Baudrilard, J. (1994), The Illusion of the End, Cambridge Polity Press.
- Jameson, Fredric (2006), Postmodernism OR The Cultural Logic of Late Capitalism, Duke University Press, Durham.
- Giddens, Anthony (1990), The Consequences of Modernity, Cambridge Polity Press.
- Gupta, Dipankar (2000), Mistaken Modernity, Harper Collins Publishers, India.

JOURNAL:

- Sociological Bulletin (upcoming editions from SAGE, India)

4. OTHER SESSIONS

TUTORIALS: Three

PROJECT: Thematic projects on current social issues and environmental issues

MODE OF CONDUCT: Lecture, Tutorial, Power- point Presentations (PPTs), Audio Visual/ Video documentary on current issues, group discussions, etc.

5. ASSESSMENT:

Performance of the students may be assessed by two class tests of 10 marks each, project report submission of 10 marks and presentation on the assigned topic of 10 marks with Final exam/ End semester exam of 60 marks and then grades may be assigned.

6. OUTCOME OF THE COURSE:

At the end of the course, students are expected to increase their understanding on the basic concepts and social issues. Though the topics chosen here seems subjective but at the end, students' logical understanding will be improved and they will analyse the social issues and social facts in their objectivity. It is assumed that they would be able to apply their scientific knowledge and understanding in all their social actions.



EPOCHAL SHIFT

Course Code-HSMC (HSL-309)

MODERNITY

- Conceptual understanding: centring, consensus and monoculture
- Main attributes: rationalization, linearity and compartmentalization
- Understanding of change and order: Macro theories (Conflict school and Functional theory)
- Discontents: critical understanding: Frankfurt school.

POST MODERNITY

- Conceptual understanding: de centring, differ, Multicultural
- Main attributes: Hybridization and convergence
- Understanding change: Micro theories (Ethno -methodology and symbolic interactionism)

READING MATERIAL:

- Classical and contemporary sociological theory, sage publications
 - Virtue Ethics and Sociology
 - Editors: **Flanagan, Kieran, Jupp, Peter C.** (Eds.) Issues of Modernity and Religion, Palgrave Macmillan UK,2000
 - Consequences of modernity by Anthony Giddens, Stanford press, 1990
 - Globalization: Bauman, polity Press,2000
 - Yogender Singh: Modernization of Indian tradition, Thomson, 1972
 - Dipankar Gupta, Mistaken modernity Mistaken Modernity
 - *India between Worlds, Harper collions, 2000*
 - Avijit Pathak, Indian modernity,Aakar,2001
-



VALUES & ETHICS

Course Code: HSMC (HVE-310)

1. Definition and classification of values: Extrinsic values, Universal and Situational values, Physical, Environmental, Sensuous, Economic, Social, Aesthetic, Moral and Religious values.
2. Concepts related to values: Purusartha, Virtue, Right, duty, justice, Equality, Love and Good.
3. Egoism, Altruism and universalism. The Ideal of Sarvodaya and Vasudhaiva Kutumbakam.
4. The Problem of Sustenance of value in the process of Social, Political and Technological changes.
5. The Problem of hierarchy of values and their choice, The views of Pt. Madan Mohan Malviya and Mahatma Gandhi.

BOOKS SUGGESTED

1. डॉ. शंभुनाथ शर्मा : नीशातिका™ (Motilal Banarasidas, 2005)
 2. डॉ. व. वि. दी. प. का. वि. म. : नाशातिका™ का मूलोत्पत्ति, (Allied Publication, Delhi, 1977)
 3. डॉ. स. ग. म. ल. ल. प. : नाशातिका™ का संवर्धन (सं. द. ल. प. शा. वि. ग. हा. द. स., इ. ल. हा. बा. द.-2005)
 4. Little, William, : An Introduction of Ethics (allied Publisher, Indian Reprint 1955)
 5. William, K Frankena : Ethics (Prentice Hall of India, 1988)
 6. Dr. Awadesh Pradhan : Mahamana ke Vichara. (B.H.U., Vanarasi-2007)
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ETHICS AND HOLISTIC LIFE

Course Code: HSMC (HVE-311)

(Duration: 26 hours/classes)

1) OBJECTIVE:

In this course it is emphasized that understanding the meaning and nature of ethics, human values and holistic life for leading a good, successful and happy life through continuous examination of thoughts and conduct in day to day life. The status and responsible role of individual in abatement of value crisis in contemporary world in order to develop a civilized and human society. Understanding the process of ethical decision making through critical assessment of incidents/cases of ethical dilemmas in personal, professional and social life.

Thus it is considered necessary to view place of Ethics and Human Values in development of individual and society through identification and cross examination of life values and world view of his/her role models in society.

2) COURSE TOPICS

1. Human Life, its aim and significance: The concept of a successful life, happy life and a meaningful life.
2. Ethical and decision making capability and its development: Meaning of Ethical dilemma, sharing real life experiences.
3. Creative and Leadership ability and their development: Intellectual, Emotional, Creative, Ethico-spiritual development, Aesthetic sense, Self-dependency, Activeness.
4. Development of positive attitude.
5. Harmony in Personal and Social Life: Concept of personal and group Ethics; Balance between - rights and duties-welfare of self and welfare of all.
Creating a value based work culture in hostel, classroom and other places in the campus and society.
6. Character, Righteousness and Virtues for a Meaningful Life: Egolessness, Humility, Righteousness, Purity, Truthfulness, Integrity, Self-restraint, Self-control, Sense of responsibility, Empathy, Love, Compassion, *Maitri*/ Comradship, Cooperation, Tolerance.
7. Dilemma Between materialistic development and human welfare: Science, Technology, Consumerism, Relation with Nature and Environment.
8. New dimension of Global Harmony: Democracy, Equality, Social Justice

3) ASSESSMENT:

Project and term paper be there. Project may be survey based or interview based reflecting real view and opinion of common people, academics, activists, thinkers which will help students to make their concrete path of future life.



4) OUTCOME OF THE COURSE:

To enable students to understand the concept of contemporary ethics at different levels: Individual, local and Global and enable them to cross examine the ethical and social consequences of the decisions of their life-view and world view.

To develop the ability of students to create a balance between their individual freedom and social responsibilities and enable them to identify the personal, professional and social values and integrate them in their personality after cross examination.

To enable students to cross examine their earlier decisions taken in life and understand the meaning of ethical dilemma to overcome the ethical dilemmas and engage in critical reflection.

To develop positive habits of thought and conduct and work cohesively with fellow beings who have variety of strengths, experiences, shortcomings and challenges, hence to enable them to handle diverse type of personalities.

To enable students to develop a method for making ethically sound decisions for themselves, within hostels, classrooms, university campus and society.



FOLK AND VERNACULAR EXPRESSIVE TRADITIONS AND POPULAR CULTURE
Course Code: HSMC (HCL-313)

COURSE DESCRIPTION:

While Indian culture is known for its diversity and plurality, and also for unity which underlies this diversity, this diversity and unity has been perceived and studied only in terms of classical traditions. Popular folk and vernacular expressive traditions and practices as being manifestations and embodiments of cultural values as of cultural diversity of our society/ community have largely remained unexplored. These practices and traditions play a crucial role in the making of social life, and through them people construct for themselves, individually and collectively, a sense of shared lived past and membership in various communities.

The preservation of folk and vernacular expressive traditions and practices becomes imperative in our Indian context especially in view of the fact that the diversity and plurality and the underlying unity of Indian civilization is under continual threat from the forces of cultural homogenization on the one hand, and numerous fissiparous tendencies like communalism, regionalism, resurgence of linguistic identities and popular insurgencies in different parts of the country on the other. So far, our country has been able to nurture and sustain this diversity because different identities—religious, cultural, social, linguistic, ethnic etc.—have the space and potential for co-existence, not in insularity, but in communication and interaction with other. Any attempt to freeze or isolate particular identities and not allowing fluidity can be a deterrent to the dynamics of the interwoven web of cultural diversity of our country and civilization, thus disrupting the peace and harmony, and also the process of development and growth. Our folk and vernacular expressive traditions and practices have always played a major role in maintaining and sustaining the cultural diversity through a process of intercultural dialogue and exchange.

Drawing on the range of insights and practices evolved in Culture Studies which has emerged as an interdisciplinary field of inquiry intersecting humanities, social sciences, sciences and the arts, the course aims at exploring these traditions in their historical, social and cultural contexts. Such an approach would enable us to meaningfully engage and interact with these new modes of being and doing. By making us conscious of the many complex ways in which power impinges on our lives and constructs our cultures, it has the potential of empowering us to critically read cultural institutions and texts, to understand how they shape our identities and to think about how we could possibly shape them.

Course Units:

- I. Expressive Traditions, Culture and Development
- II. Expressive Traditions and Lok Vidya
- III. Expressive Traditions and Lived Religion
- IV. Expressive Traditions, Community and Identity
- V. Expressive Traditions and Gender



READINGS:

Course readings will be announced in the class.

ASSESSMENT AND GRADING:

Discussion:	30%
Project:	30%
End Term Exam:	40%

EXPECTED LEARNING OUTCOME:

The course will create among students a better understanding and appreciation for our cultural diversity and plurality; and this, in turn, would promote and encourage among them a spirit of mutual understanding, cooperation and respect for one another and the diverse ways of life, thus leading to reduced social conflict and tension which has become the bane of our society. By ensuring harmonious interaction among people and groups with varied backgrounds, it will promote social cohesion and stability thus bringing in alienated and marginalized minority groups into the mainstream of national activity, and make them stakeholders and equal partners in the task of nation- building.



UNIVERSAL HUMAN CONDUCT Course Code: HSMC (HVE-315)

Credits: 9(L-T-P::3-0-0)

Pre-Requisites: Knowledge of Hindi Essential, The course will be taught in Hindi.

● OBJECTIVES:

This course is designed for transferring the right understanding and definite human conduct in the students. The conduct of every human differs from human to human. Through this course an attempt is being made to introduce the definite human conduct in students. The conduct of a human being can be definite only if knowledge of right understanding and right human conduct is taught to them.

● COURSE TOPICS:

2.1 मानव मूल्य तथा (याचिापूर्णता) (6L)

जीवन म हने वाली 10 शायाए, आाादन, चयन, तुलना, शावतािषण शाचतन शाचरण, ब ध, सका, अनुभव, पमाशाणकता ।
िरीर मे ह ने वाली शायाए ।

2.2 मानवीितापूर्ण आचरण (आचरणपूर्णता) (3L)

मानवके प्रकार और उनके भाव, शावषय एवशा या ।

2.2.1 मूा (12L)

(A) पखवार मूा, (12L)

शाशापत मूा: शावशास, समान, आेह, ममता, वाा, कृ ता, ग रव, फाा Pाेम ।

शाशा मूा: स जाता, स हदता, शाना, उदारता, सहजता, समयता, सरलता, पूाता, अनता

|

(B) मानव मूा, (4L)

धीरता, वीरता, उदारता, दया, कृता ।

(C) जीवन मूा, (2L)

सुख, शाशात, सांतष, आनद ।

(D) वता मूा, (2L)

उपयशागता, कला ।

2.2.2 चर (3L)

धन, अनारी/पुष, दयापूर्ण व्यवहार और काय ।

2.2.3 नैशातकता (6L)

अथनीशात, धमनीशात, एव राानीशात ।



● **READINGS**

TEXTBOOKS:

- “Foundational Course in Human Values & Professional Ethics” by R Sangal, RR Gaur and G P Bagaria.
- जीवन शाव4ाT: एक परचय: <http://www.madhyasth-darshan.info>]

*REFERENCE BOOKS:

- मानव व्य३/4 ंTर दि'न[<http://www.madhyasth-darshan.info>]
- मानव कम' दि'न [<http://www.madhyasth-darshan.info>]

● **OTHER SESSIONS**

- * TUTORIALS: YES
- * LABORATORY: NIL
- * PROJECT: YES.

- **ASSESSMENT** (Indicative only): To be specified by the instructor concerned, at the beginning of the semester.

5.1 HOME ASSIGNMENTS AND QUIZZES: [10% GRADE]

5.3 PERIODICAL EXAMS: [30% GRADE]

FINAL SEMESTER EXAM: [40% GRADE]

TERM PAPER: [20% GRADE]

● **OUTCOME OF THE COURSE:**

This course introduces the concepts of right understanding and definite human conduct in the students. This course will introduce the definite human conduct and right understanding in the students.



GENDER, CULTURE AND DEVELOPMENT

Course Code: HSMC (HSL-316)

COURSE DESCRIPTION

This course offers an introduction to Gender Studies, an interdisciplinary field that asks critical questions about the meanings of sex and gender in society. The primary goal of this course is to familiarize students with key issues, questions and debates in Gender Studies, both historical and contemporary. It draws on multiple disciplines – such as literature, history, economics, psychology, sociology, philosophy, political science, anthropology and media studies – to examine cultural assumptions about sex, gender, and sexuality. This course integrates analysis of current events through student presentations, aiming to increase awareness of contemporary and historical experiences of women, and of the multiple ways that sex and gender interact with race, class, caste, nationality and other social identities.

This course also seeks to build an understanding and initiate and strengthen programmes combating gender-based violence and discrimination.

The course also features a number of exercises and reflective activities designed to examine the concepts of gender, gender-based violence, sexuality, and rights. It will further explore the impact of gender-based violence on education, health and development.

MODULE 1: Introduction to Gender

- Definition of Gender
- Basic Gender Concepts and Terminology
- Exploring Attitudes towards Gender
- Social Construction of Gender

MODULE 2: Gender Roles and Relations

- Types of Gender Roles
- Gender Roles and Relationships Matrix
- Gender-based Division and Valuation of Labour

MODULE 3: Gender Development Issues

- Identifying Gender Issues
- Gender Sensitive Language
- Gender, Governance and Sustainable Development
- Gender and Human Rights
- Gender and Mainstreaming



MODULE 4: Gender-based Violence

- The concept of violence
- Types of Gender-based violence
- The relationship between gender, development and violence
- Gender-based violence from a human rights perspective

MODULE 5: Gender and Culture

- Gender and Film
- Gender and Electronic Media
- Gender and Advertisement
- Gender and Popular Literature

READINGS:

Course readings will be announced in the class.

Classes will consist of a combination of activities: dialogue-based lectures, discussions, collaborative learning activities, group work and in-class assignments.

ASSESSMENT AND GRADING:

Discussion & Classroom Participation:	20%
Project/Assignment:	30%
End Term Exam:	50%



INTRODUCTION TO WOMEN'S AND GENDER STUDIES

Course Code: HSMC (HSL-317)

COURSE OUTLINE

Unit-I

Concepts

- Sex vs. Gender, masculinity, femininity, socialization, patriarchy, public/ private, essentialism, binaryism, power, hegemony, hierarchy, stereotype, gender roles, gender relation, deconstruction, resistance, sexual division of labour.

Unit-II

Feminist Theory

- Liberal, Marxist, Socialist, Radical, Psychoanalytic, postmodernist, ecofeminist.

Unit-III

Women's Movements: Global, National and Local

- Rise of Feminism in Europe and America.
- Women's Movement in India.

Unit-IV

Gender and Language

- Linguistic Forms and Gender.
- Gender and narratives.

Unit-V

Gender and Representation

- Advertising and popular visual media.
 - Gender and Representation in Alternative Media.
 - Gender and social media.
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ADVANCE COURSE IN PEACE RESEARCH

Course Code: HSMC (HSL-318)

COURSE OBJECTIVES:

The Advance course in Peace Research offers a state of the art opportunity for students and practitioners from diverse fields concerned with peace, security and community development. Assisted by highly trained faculty from within and outside the country, this unique course is proposed to take the students step-by-step through the process of analyzing the links between development, peace, faith and security in an increasingly globalized world- a world in need of creative and pragmatic thinkers in developing pedagogy and understanding of how to handle a conflict situation and transform conflicts towards positive social change. Students will develop important conflict management knowledge and skills that are increasingly sought after in today's job market. A primary goal of this course is to assist students who want to become agents of social change to promote peace and reduce violence.

The main objective of the course is to equip the students with field work skills to analyze and handle today's conflicts and to engage with peace building and conflict prevention as both critical pedagogy and active vocation.

Unit 1

Origin and Growth of Peace and Conflict Studies

Unit 2

Understanding Positive and Negative Peace

Unit 3

Understanding Conflict: Theoretical Constructs

Unit 4

Violent and Non-Violent Conflicts

Unit 5

Structural and Cultural Violence

Unit 6

Types of Conflict: Ethnic Conflict, Clash of Civilization and Environmental Conflict

Unit 7

Conflict Management and Conflict Resolution

Unit 8

Gandhi's Approach to Peace

Unit 9

UN System: Peace Making, Peace Keeping, Peace Building

Unit 10

Peace, Development, Faith and Security: An Integrated Focus

Unit 11

Conflict Handling Mechanism: Force, Adjudication, Arbitration, Negotiation, Mediation, Reconciliation and Dialogue

Unit 12

Conflict Management to Conflict Transformation



Unit 13

Citizen's Diplomacy

Unit 14

Alternative Dispute Resolution (ADR)

Unit 15

Role of Civil Society and NGO's in Peace Processes

Unit 16

Human Development and Human Security

Unit 17

Linking Gender, Conflict and Development

Unit 18

Environment, Conflict and Development

RECOMMENDED READINGS:

Reading List

- Bajpai, K. 2000. 'Human Security: Concept and Measurement.' Kroc Institute Occasional Paper, no.19, OP.1, August.
 - Bercovitch, Jacob, et.al. 2009. The Sage Handbook of Conflict Resolution. New Delhi: Sage Publication.
 - Commission on Human Security. 2003. Human Security Now. New York: Commission on Human Security.
 - Fisher, Simon, et al. 2000. Working with Conflict: Skills and Strategies for Action. London: Zed Books.
 - Galtung, Johan, 1996. Peace by Peaceful Means. London: Sage Publication.
 - Haq, Mahbub ul. 1995. Reflections on Human Development. New York: Oxford University Press.
 - Huntington, Samuel P. 1996. The Clash of Civilizations and the Remaking of World Order. New York: Simon and Schuster.
 - Jeong, Ho-Won. 2000. Peace and Conflict Studies: An Introduction. Aldershot: Ashgate.
 - Jeong, Ho-Won. 2008. Understanding Conflict and Conflict Analysis. New Delhi: Sage Publications.
 - Juergensmeyer, Mark. 2002. Gandhi's Way: A handbook of Conflict Resolution. Mass: University of California.
 - Kriesberg, Louis. 1998. Constructive Conflicts: From Escalation to Resolution. New York: Rowman and Littlefield
 - Sen, Amartya K. 1999. Development as Freedom. New York: Knopf Press.
 - Upadhyaya, Priyanka. 2004. 'Human Security, Humanitarian Intervention and Third World Concerns.' Denver Journal of International Law & Policy, 33(4).
 - Wallensteen, Peter, 2007, Understanding Conflict Resolution: War, Peace and the Global System, Britain: Sage.
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CONTEMPORARY INDIA IN GLOBALIZED ERA: CHALLENGES OF DEMOCRACY AND DEVELOPMENT

Course code: HSMC (HPL-306)

Credits: L-T-P - Credit 3L+2T+P

1. OBJECTIVE:

This course introduces students to contemporary India with special focus on challenges of democracy and development and main vectors that are moulding India's course in today's globalised era. The course begins with an overview of India's emergence from colonial trappings and its progression in past decades to acclaim a global stature in world affairs. It deliberates on major issues of Indian foreign policy, especially the problematic of peace and security in the globalised world. The overall aim is to develop a broad and yet nuanced understanding of prospects and challenges of contemporary India in the twenty-first century.

2. COURSE CONTENT

Unit I: Contextualising Modern India

- (a) Overarching visions of India's national movement: domestic and international
- (b) Challenges of nation-building within its domestic contours
- (c) Continuities and shifts in Indian polity and society
- (d) Rising aspirations and constraints in post Globalized era
- (e) Digitising India: Prospects and Challenges

Unit II: India in World Affairs

- (a) Gandhi-Nehru Legacy and policy of nonalignment: Formative Years
- (b) Post-Cold war challenges and changing global configurations
- (c) India's growing role in world affairs: soft power capacity, diaspora, major bilateral, regional and global concerns and aspirations
- (d) India and Major Powers
- (e) India and its neighbours
- (f) India and Brics

Unit III: India's security concerns

- (a) External Threats: China and Pakistan
- (b) Internal Threats: Kashmir and Northeast
- (c) Spectre of Terrorism

Unit IV: Non-traditional Security

- (a) Human Security Concerns:
- (b) Energy Security
- (c) Water and Food Security
- (d) Health and Safety

Unit V: Challenges ahead

India has had a phenomenal rise in terms of economic growth, technical knowhow, and has performed well on various other parameters. Nonetheless there are severe constraints to its unfolding. This topic will cover some of the challenges that India is facing today and the measures it is taking to overcome them.



Reference books: Select chapters from the following will be assigned reading for each class.

Unit 1. Contextualising Modern India:

- Candra Bipin, 'Freedom Struggle'
- Ram Chandra Guha, 'India after Gandhi'
- Tharoor, Shashi. 'India: From Midnight to the Millennium'
- Chandra, Bipan. 'India since Independence'
- Sen, Amartya. 'Development as Freedom'
- Ninan Thomas, Pradeep. 'Digital India: Understanding Information, Communication and Social Change'

Unit II. India in World Affairs:

- Menon, Shivshankar. 'Choices: Inside the Making of Indian Foreign Policy'
- Wajid Ali, H.M. 'India and the Non-aligned Movement'
- Mandrup, Thomas. 'The BRICS and Coexistence'
- Sikri, Rajiv. 'Challenge and Strategies: Rethinking India's Foreign Policy'

Unit III. India's Security Concerns:

- P. Bajpai, Kanti. Pant, Harsh.V. 'India's National Security'
- Budhanja, Rajpal. 'India's National Security Dilemma'
- Sondhi. M.L. 'Nuclear Weapons and India's National Security'

Unit IV. Non-traditional Security:

- Centre for Strategic Studies - 'Energy Security Challenges: Non Traditional Security Planning in India'
- Asthana, Vandana. Shukla, A.C. 'Water Security in India'
- Kolas, Ashild and Miklian, Jason. 'India's Human Security: Lost Debates, Forgotten People, Intractable Challenges'.

Unit V: Challenges ahead:

Venkateshwar, Sita. 'Globalisation and the Challenges of Development in Contemporary India'

ASSESSMENT:

There will be continuous assessment in this class. The breakup of the same will be as follows:

- Class participation 25% based on interaction and reading responses
- Group presentation 25% This can be in the form of short audio-visual presentations, role play, problem solving exercises, and mini theatre presentation on themes related to the course.
- End semester term paper 50%. The term paper will offer students tremendous freedom to develop their own trajectories in the field taught.

OUTCOME: The student will develop a good sense of India's location in world politics and acquire a capacity to critically assess the prospects of the country in a globalised world. Besides, they will develop ingenious faculties and respond to the pressing matters of the contemporary world more successfully.



**MAKING INDIAN CULTURE:
EPISTEMIC TRADITIONS, LITERATURE AND PERFORMATIVE ARTS
Course Code: HSMC (HCL-319)**

OBJECTIVE:

The Objective of this course is to develop an indigenous, Non- European perspective to study the dynamics of Indian Civilization. It will largely focus on its continuum or spectrum of continuity with change. Since the dynamics of all the civilizations vary from one another, so do their priorities. Consequently, the domains of their achievements and excellence in every respect will also be divergent and therefore, the parameters to study their dynamics must not be rooted exclusively in European matrix. This emphasizes that instead of applying the Eurocentric approach to study the dynamics of Indian civilization, an indigenous approach is needed. The knowledge of Indian civilization has been created by Europe. Later on, Indian scholars have tried to challenge this orientalist creation in order to retrieve the dynamics of Indian civilization. However before doing this, they appear to have accepted the superiority of European civilization. And therefore, while devising an apparently indigenous civilizational model, they started showing that Indian Civilization had all that was claimed to be base of uniqueness of European civilization. Thus, instead of creating an indigenous model, Indian scholars imitated the European one. Therefore, this course will make an attempt to foster an indigenous perspective that will help in retrieving the dynamics, priorities and insights of Indian civilization disembedding it from the imitation of European model. First, it will show its achievements and then, will compare them to those of other civilizations. Thus, this indigenous and comparative approach will usher in a new era of dialogue among the various civilizations on equal footing. At the same time, it will aim at breaking the disciplinary boundary by taking the recourse to an interdisciplinary approach, and bringing out the totality of Indian civilization. This course will explore the changes in language, literature, music, arts, religion, philosophy and folk culture of North India in the second Millennium. This exploration will also underline the process of making of the Modern India. As it is believed that The Modern India is the invention of the British colonialism, in reality, it is not so. The dynamics of Indian Civilization itself was capable of giving birth to Indian Modernity. However the colonial intervention disrupted this process and it was claimed that India became modern only because of the colonialism. Thus, this course aims at exploring the dynamics of Indian modernity which was lost under the colonial subjugation.

SYLLABUS:

UNIT-1: THE VERNACULAR MILLENNIUM

TOPICS

- A- The Emergence of Modern Indian Languages with special reference to Hindi**
- B- Bhakha and its regional variations**
- C- The Idea of Hindi, Rekhta, Urdu and Hindustani**

Text

Poems: Vidyapati, Maulana Daud and Vishnudas

Reference Books

Sunil Kumar.	The Emergence of the Delhi Sultanate
Hazari Prasad Drivedi	Nath Sampradaya
Dharmveer Bharati	Siddha Sahitya



Unit-2: Early Modern India: Mughal Period and After

Topics

A- Religious Sects and Indian Islam

B- Bhakha and Braj Bhasha

C- Performative Tradition: Poetry and Music

D- Text and Telling

Text

Poems: Kabir, Jayasi, Surdas, Meera Bai and Tulsidas

Poems: Bihari and Ghananand

Reference Books

Irfan Habib	Medieval India: A Study of Civilization
J.L.Mehta	Advanced Study in the History of Medieval India, Vol. III: Medieval Indian Society and Culture
Meenakshi Khanna	Cultural History of Medieval India
Hazari Prasad Drivedi	Hindi Sahitya ki Bhumika
Richard Eaton	India's Islamic Traditions, 711-1750
Barabara D Metcalf.	Islam in South Asia in Practice
S. M. Ikram.	Muslim Civilization in India
D. D. Kosambi.	An Introduction to the Study of Indian History
Saiyid Athar Abbas Rizvi	A History of Sufism in India
David Lorenzen	Religious Movements in South Asia 600-1800
David Lorenzen	Bhakti Religion in North India
Francesca Orsini .	After Timur Left: Culture and Circulation in Fifteenth-Century North India
Muzaffar Alam.	Writing the Mughal World
JonardenGaneri	The Lost Age of Reason
Sheldon Pollock	TheCosmpolitan Vernacular (Essay)
_____	India in the Vernacular Millennium: Literary Culture and Polity, 1000-1500 (Essay)
_____	Indian Knowledge System on the Eve of British Colonialism
Sanjay Shubramanayam	Vignette of Early Modernity in South Asia
Vasudha Dalmia	Religious interaction in Mughal India
Imtiaz Ahamad	Lived Islam in South Asia



Unit-3: Colonial and Postcolonial India

Topics

A- Orientalism and India

B- Translating India: Language of Command and Command of Language

C- Colonial Modernity: Renaissance and Nationalism

D- Postcolonial Critique and Indian Modernity

Text

Bhartendu Harishchand	Andher Nagari
Premchand	Godan
Habib Tanvir	Plays
Vijaydan Detha	Short Stories

Reference Books

K. M. Sen	Hinduism
Nicholas B Dirks	Castes of Mind
Andrew J Nicholason	Unifying Hinduism
GyanendraPandeya	The Construction of Communalism in Colonial North India
RanjitGuha	Some Elementary Aspects of Peasant's Interaction in Colonial India
Ashish Nandy	The Intimate Enemy
Kaviraj	The Imaginary Institution of India
William Crooke	The Tribes and Caste of North-Western Provinces of India.
Grierson	Linguistic Survey of India
W. Theodere de Bary	Sources of Indian Tradition
SudhirChandra	the Oppressive Present
Romila Thappar.	The Past as Present
Sunil Khilnani	the Idea of India
Sanjay Subhramanayam	Connected History
David Lorenzon	Who Invented Hinduism?
Nehru	The Discovery of India
Dinkar	Sanskritike Char Adhyaya
Mahatam Gandhi	Hind Swaraj
K. C. Bhattacharya	Swarajya of Mind
LeelaGhandhi	Postcolonial Theory
Vinay Dharwadker	The Collected Essays of A. K. Ramanujan
Dipesh Chakrabarty	Provincializing Europe



HUMAN RELATIONS AT WORK
Course Number: HSMC (HPY-306)

Credits: 2-1-0-8

Prerequisite course: HPY 303: Applications of Psychology

1. OBJECTIVES:

The objectives of this course are to make students:

- 1) aware of human relations at work its relationship with self.
- 2) aware about the processes involved in interaction with people at work.
- 3) understand the importance of psychological and physical health in maintaining human relations at work and progressing in career.

2. COURSE TOPICS:

Unit I: Understanding and Managing Yourself: Human Relations and You: Self-Esteem and Self-Confidence: Self-Motivation and Goal Setting; Emotional Intelligence, Attitudes, and Happiness; Values and Ethics and Problem Solving and Creativity.

Unit II: Dealing Effectively with People: Communication in the Workplace; Specialized Tactics for Getting Along with Others in the Workplace; Managing Conflict; Becoming an Effective Leader; Motivating Others and Developing Teamwork; Diversity and Cross-Cultural Competence.

Unit III: Staying Physically Healthy: Yoga, Pranayam and Exercise: Aerobic and anaerobic.

Unit IV: Staying Psychologically Healthy: Managing Stress and Personal Problems, Meditation.

Unit V: Developing Career Thrust: Getting Ahead in Your Career, Learning Strategies, Perception, Life Span Changes, Developing Good Work Habits.

Required Text:

- Dubrien, A. J. (2017). Human Relations for Career and Personal Success: Concepts, Applications, and Skills, 11th Ed. Upper Saddle River, NJ: Pearson.

Readings:

1. Greenberg, J. S. (2017). Comprehensive stress management (14th edition). New York: McGraw Hill.
2. Udai, Y. (2015). Yogasan aur pranayam. New Delhi: N.S. Publications.



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Course Code: HSMC (LLG-305)

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LANGUAGE AND COMMUNICATION
Course Code: HSMC (LLG-306)

1. APPROACHES TO COMMUNICATION:

- a) The information Processing school, Shannon and Weaver; A Mathematical Theory of Communication, Formal Signal Processing approach.
- b) Semiotic approach; information, communication and significance.
- c) Chomskyan distinction between language structure and language use; form and function.
- d) Towards a theory of performance; acceptability and grammaticality.
- e) Communicative Competency; Possibility, appropriacy, feasibility.

2. MEANING IN LANGUAGE USE:

- a) Speech Act Theory; communicative activity, locutionary act, directives, commissives, expressive, declarations and representatives.
- b) Grice's theory of conversational meaning; the cooperative principle, quantity maxim, quality maxim, relational maxim, manner maxim.
- c) Ancient Indian theory of meaning; lexical, compositional, extended.
- d) Speaker intention in communication.
- e) Discourse meaning; context and situation.

3. LINGUISTIC AND NON-LINGUISTIC RESOURCE OF COMMUNICATION:

- a) Writing and Speech.
- b) Gestures and Body language.

4. STRUCTURE OF DISCOURSE/CONVERSATION:

- a) Coherence
- b) Cohesion
- c) Initiating and closing conversations
- d) Intervention
- e) Turn taking

5. POWER STRUCTURE AND LANGUAGE USE:

- a) Gender and language use
- b) Politeness expressions and their use
- c) Ethical dimensions of language use
- d) Language rights as part of human rights



6. MEDIA COMMUNICATION:

- a) Power of media, Orwell's problem (Chomsky)
- b) Manufacturing of opinion and hidden agendas.

7. PERSUASIVE COMMUNICATION AND MISCOMMUNICATION:

- a) Fundamentals of persuasive communication.
- b) Persuasive quotient
- c) Politics and communication barrier.

TEXT BOOKS:

1. Austin, 1962, J.L. How to do things with words. Oxford: Clarendon Press. Grice, P.1989. Studies in the way of words. Cambridge, M.A: Harvard University Press.
 2. Chomsky, N.1966. Aspects of the theory of syntax, The MIT press, Cambridge. Chomsky, N.2006. Language and Mind, Cambridge University Press.
 3. Hymes. D.N. 1972, On communication competence in J.B. Pride and J.Holmes (ed), Sociolinguistics, pp 269-293, London Penguin.
 4. Gilbert, H.Harman, 1976. Psychological aspect of the theory of syntax in Journal of Philosophy, page 75-87.
 5. Stephen. C. Levenson, 1983, Pragmatics, Cambridge University press.
 6. Stangley, J. 2007. Language in Context. Clarendon press, Oxford.
 7. Shannon, 1942. A Mathematical Theory of Communication.
 8. Searle, J.R. 1969. Speech acts: An essay in the philosophy of language. Cambridge: Cambridge University Press.
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LANGUAGE AND LINGUISTICS

Course Code: HSMC (LLN-307)

1. **How do human languages (spoken and signed) differ from means of communication used by other animals?**
 - (a) "Design Features" of human languages
 - (b) Innateness and (social) learning —"copying" and the spread of cultural phenomena.
 - (c) Patterns vs Rules vs Analogies.
 - (d) What language "Acquisition" and "Transmission" really mean?
 - (e) Structural complexity of spoken languages — the significance of modularity.
 - (f) Speaker-Idexicality — language and identity (race/ethnicity, socio-economic, class, gender, age group, education, professional affiliation, etc.)
2. **Why do human languages differ structurally, despite their architectural Similarities? (Sense of typology).**
 - (a) Variation vs transformational evolution.
 - (b) Word order typology.
3. **Structure and structure dependence:**
 - (a) Diagnostics for structure; reference, co-reference and anaphoric reference; deixis, demonstratives, tense, pronominal. b) Context; topic, focus, focusing devices.
 - (b) Thematic role; agent, patient, goal.
 - (c) Grammatical relation; subject and object.
 - (d) Case; nominative, accusative.
4. **Phrase structure;**
 - (a) X-bar theory; head, complement, specifies.
 - (b) S as IP and S-bar as CP.
 - (c) DP analysis of noun phrase.
 - (d) Syntactic operation; move; relative clause.
5. **Meaning;**
 - (a) Sense and reference and denotation and connotation.
 - (b) Synonymy, antonym, hyponymy.
 - (c) Propositions; ambiguity, generic vs specific, definite and indefinite.
6. **Pragmatic:**
 - (a) Presupposition.
 - (b) Entailment.
 - (c) Implicate.

Text books:

- Akmajian, A and Heny, F 1975. An Introduction to the Principles of Transformational Syntax, Cambridge, Mass: MIT Press.
- Chomsky, N and Halle, Morries 1966. Studies in Language, Harper and Row, publishers. New York .
- Bolinger, D.L. 1980, Language, the Loaded Weapon, London: Longman. Stephen. C. Levenson, 1983 Pragmatics, Cambridge University Press.
- Song, Jae Jung, 2001 Linguistic Typology. Pearson Education Limited.



UNDERSTANDING SOCIETY AND CULTURE THROUGH LITERATURE

Course code: HSMC (LLT-301)

1. OBJECTIVE:

The ultimate aim of the teaching-learning process should not only be about acquiring skills necessary for one's "trade", but to acquire knowledge and become a better human being, as a means towards the end of creating a better society. Understanding a society, its people, their mind, prevalent traditions and culture is imperative in developing a holistic worldview, which is essential for a sustainable society. In this course we shall pick up literary works of various countries/ regions / societies (referred to as "traditions" hereafter); and as it has been quoted often by many that - "Literature is the mirror of the society" – to the extent that it has almost become a saying – we shall read these works and attempt to understand the respective traditions to which the works belong.

2. COURSE TOPICS:

Literary works of various traditions would be the primary study material in this course. Through these works we will attempt to understand various aspects of the society. The course may be divided into the following units.

Introduction (4 Hours)

Knowledge tradition, what is Literature, Significance of studying literature, how to study society and culture through literature

Morality (7 Hours)

Various literary pieces will be picked up that would help us to understand morality.

Dilemma (7 Hours)

Various literary pieces will be picked up that would force us to think about situations where one is faced with a dilemma; where such ethical questions arise that differentiating between right and wrong becomes very difficult. This forces us to re-think our notions of right and wrong and helps us in understanding the various realities of life.

Gender (7 Hours)

Various literary pieces will be picked up that questions the current notions of gender, and raises uncomfortable questions, challenging the status-quo, forcing us to think the real meaning of equality and emancipation.

3. READINGS:

Literary works – Will be provided by the teacher.

Author's Background, Historical and Social Background which are significant for a better understanding of the work – Will be provided by the teacher.

Any other significant study material as required for an overall understanding of the literary work.



4. OTHER SESSIONS:

The study of each literary piece would be divided into the following sessions.

Reading – The literary piece will be given to students beforehand and they are required to read it before coming to the class so that they are not totally unaware of the text. In the class the text will be read once again, where doubts if any will be cleared.

First Discussion – The reading will be followed by a discussion where the text will be analyzed in detail. The students will be encouraged to share their interpretation of the text.

Presentation – Having read and analyzed the text by now, the students will present their analysis of the text in front of the class. The students will keep in mind the author’s background and the socio-historical and cultural backgrounds while preparing this presentation.

Q&A Session – Each presentation will be followed by a Q&A session wherein the students will be encouraged to ask questions to their respective classmates regarding the presentation/ analysis initiating a second discussion on the text.

Second Discussion – Having made their presentation, and heard the presentations made by their classmates, the students would now have a fairly good idea of the various nuances of the text, making it a ripe moment to have the second detailed discussion on the text. Here the teacher may refer to those points which may have been missed by the students.

Submission of a report – Having faced questions from their classmates, and after having a second discussion on the text, the student would come across new ideas which will be incorporated into the analysis and submitted in the form of a report.

5. ASSESSMENT:

1 Sessional Test (15%) + 1 Sessional Test (15%), 1 Term Paper (30%), End Semester Examination (40%)

6. OUTCOME OF THE COURSE:

Awareness of various traditions.

Ability to not just understand the diversity found between various traditions but to celebrate them.

Strengthening of the analytical capability.

Improvement in language skills and ability of expressing complex ideas.

7. *ANY OTHER: A course of this nature requires that the class strength is not too high.



FUNDAMENTALS OF LINGUISTICS

Course Code: HSMC (LLT-302)

Fundamentals of Linguistics for B.Tech 5th Semester students

COURSE DESCRIPTION:

It will be a 3 credits Course that will introduce the students to a discipline called Linguistics which may be defined in one sentence as the scientific study of language. We will explore some basic issues and questions related to language in this course such as what do we know when we know a language, the relation between language and brain, language and society, how does a child learn a language, how the languages of the world are similar as well as different, how can we analyze language as a structure etc. The course will also provide the students to a brief outline of language studies in Indian and western tradition and many applications of linguistics in different fields.

Unit 1 (10 hours)

1. What is language and where is language?
 - a. Language is a means of communication, a social product
 - b. Language is a cognitive ability, relation between language and brain
2. What is Linguistics and what is not Linguistics?
 - a. Linguistics is not prescriptive grammar learnt in the school
 - b. Linguistics is not learning of many languages
 - c. Linguistics provides tools to analyze language structure scientifically
3. Study of Language in Indian and western traditions

Unit 2 (18 hours)

1. Levels of Language Analysis: Form and content
 - a. Sound
 - b. Word
 - c. Sentence
 - d. meaning
2. Similarities and differences of languages

Unit 3 (2 hours)

1. Applications of Linguistics
 - a. Natural Language Processing
 - b. Clinical Linguistics
 - c. Psycholinguistics etc



ELEMENTS OF LITERATURE

Course Code: HSMC (LLT-303)

1. OBJECTIVE:

To make the students aware about the finer sensibilities of human existence through an art form. The students will learn to appreciate different forms of literature as suitable modes of expressing human experience.

2. COURSE CONTENTS

Introduction to Elements of Literature

1. Relevance of literature

- a) Enhances Reading, thinking, discussing and writing skills.
- b) Develops finer sensibility for better human relationship.
- c) Increases understanding of the problem of humanity without bias.
- d) Providing space to reconcile and get a cathartic effect.

2. Elements of fiction

- a) Fiction, fact and literary truth.
- b) Fictional modes and patterns.
- c) Plot character and perspective.

3. Elements of poetry

- a) Emotions and imaginations.
- b) Figurative language.
- c) (Simile, metaphor, conceit, symbol, pun and irony).
- d) Personification and animation.
- e) Rhetoric and trend.

4. Elements of drama

- a) Drama as representational art.
- b) Content mode and elements.
- c) Theatrical performance.
- d) Drama as narration, mediation and persuasion.
- e) Features of tragedy, comedy and satire.

3. READINGS:

1. An Introduction to the Study of English Literature, W.H. Hudson, Atlantic, 2007.
2. An Introduction to Literary Studies, Mario Klarer, Routledge, 2013.
3. The Experience of Poetry, Graham Mode, Open college of Arts with Open Unv Press, 1991.
4. The Elements of Fiction: A Survey, Ulf Wolf (ed), Wolfstuff, 2114.
5. The Elements of Drama, J.L.Styan, Literary Licensing, 2011.



Textbook:

*Reference Books:: To be decided by the teacher and student, on the basis of individual student so as to enable him or her to write the term paper.

4. OTHER SESSION:

*Tutorials:

*Laboratory:

*Project: The students will write a term paper to show their understanding of a particular piece of literature

5.*ASSESSMENT:

HA:

Quizzes-HA:

Periodical Examination: one

Project/Lab: one (under the guidance of the teachers the students will take a volume of poetry, fiction or drama and write a term paper to show their understanding of it in a given context; sociological, psychological, historical, autobiographical etc.

Final Exam:

6. OUTCOME OF THE COURSE: Students will be able to understand the relevance of literature in human life and appreciate its aspects in developing finer sensibilities.



HUMANITY AND MULTIPLE DIMENSIONS OF ECOLOGY

Course Code: HSMC (LLT-308)

OBJECTIVE:

This course would explore the multiple meanings of *Oikos*, the Greek for “home”, by pluralizing the connotation of “ecology”. There can be an “ecology of mind”, as Gregory Bateson suggests. Knowledge systems, as Bateson insists, should focus on the interconnectedness of nature and culture, civilization and ancient wisdom. This course attempts to sensitize the students to the necessity of understanding and appreciating our interconnected existence on the planet – the way all living organisms, all cultures and ecologies, all human beings, animals and plants, and all societies, despite their differences and even apparent mutual conflicts, are interconnected and interdependent. Through a reading of selected texts by philosophers, social scientists, poets and novelists, and through class discussions, and audio-visual presentations, the students would be encouraged to build up a forum for debating the ethical issues that are our foremost concerns today. They would not only learn to be sensitive to natural environments and fellow human beings but also challenge the ethos of atomic individualism. The course will be interactive, and as less traditional in methodology as possible.

All the course materials will be supplied by the class instructor.

Unit 1: Redefining the *Oikos*

We will try to redefine the “oikos” by analyzing some philosophical doctrines, and explore the multiple connotations of “ecology”. It will be interesting to see how one may feel at home within a particular belief system, or a particular cultural framework, as well as natural environment, while keeping open the possibility of interlinking all these little homes, and of celebrating an inter-ecological understanding of our plural existence. In short, we will see how the concept of “home” itself may lead to certain self-critical modes of defining and exploring ecological issues. The issues we will explore are:

- a. What do we mean by a “home” (*Oikos* in Greek)?
- b. Whom can we accommodate within our “home”?
- c. How are the concepts of “home” and “hospitality” interlinked?

Texts:

Selected portions from Gregory Bateson’s *Steps to an Ecology of Mind* (one or two short chapters)

Unit 2: Oneness and Interconnectivity

We will have a look at the Vedantic concept of the Oneness of the universe and discuss its relevance to the contemporary issues of intercultural and intercommunal harmony as well as environmental balance. Besides, we will explore how the tantric traditions focus on the interconnectivity of all living beings without positing a necessary ontological hierarchy. Blending these two models, we will propose a paradigm of interconnectivity within the Oneness of the cosmos, where All and Each become one, thereby initiating a powerful mode of existential altruism.

Texts:

Selected portions from Ruth Frankenberg and Lata Mani, *The Tantra Chronicles*, selected portions of *The Life Divine* by Sri Aurobindo, and Emerson, “Each and All” (poem)

Unit 3: The Sacred, the Secular, the Sacredsecular

Here we will re-interrogate the questions relating to the sacred and the secular. The sacred, when allowed to be self-centred, may give rise to fundamentalism. And the secular, when allowed to be self-contained, may turn into an exclusivist structure and heartless materialism. So, perhaps it is necessary to blend the sacred and the secular and detach the sacred from the ritualistic framings that make it limited in scope.



The contemporary eco-consciousness and social awareness may benefit from the idea of the sacredness of life which need not be confined to any particular religious' doctrine.

Texts:

Selected portions from Lata Mani, *Sacredsecular*. Stephen Talbott, "Toward an Ecological Conversation".

Unit 4: Dharma as Regard for the Whole

Here we will explore the concept of *Bhuma* developed in the Upanishads and relate it to the issue of the *holistic* approach to our planet that is required by our contemporary ecological consciousness. Besides, we will redefine Dharma as a mode of connecting with the *Bhuma*.

Texts:

For this, we will read some Upanishadic texts, and some portions (not more than 10 pages) of Robert Pirsig's philosophical novel *Zen and the Art of Motorcycle Maintenance*. References will be made to the Goethean character Makarie who is a metaphorical composite figure for natural sciences and mystic wisdom.

Unit 5: Ecology for Women

We will explore how the "home" of the patriarchal society in which men feel at home is not a home for women. In other words, in order to make our society more habitable for women, we need to develop certain ethical attitudes that will lead to the emergence of gender justice in the contemporary society. Men must get involved in the project of gender justice, and would usher in what Betty Friedan calls "the second stage" in the fight for gender egalitarianism.

Text:

Wislawa Szymborska, "Portrait of a Woman" (poem)

Film Screening

Akira Kurosawa, *Dreams*

In a separate class the ecological themes explored in the film will be discussed.

MODE OF CONDUCT:

Students will be asked to write term papers on any innovative topic, e.g., the possibilities of modernizing the concept of Dharma and applying it to the secular context, Dharma as a mode of synthesizing freedom and responsibilities, the multiple meanings of ecology, the metaphors of chaos and cosmos in the context of Oneness and planetary plurality etc. Besides, students will be encouraged to do poster presentations and audio-visual presentations. Students will also be encouraged to present creative writing (in English or Hindi or Bengali) related to the broad theme explored in the course.

MODE OF EVALUATION:

Interaction and short class presentations will be more important than conventional modes of evaluation, and the term papers would offer the students tremendous creative freedom. 40-50% weightage would be given to the term papers, while 20-30% will be on group presentations (audio-visual, power point or poster presentations)/creative writing (individual or collaborative).

OUTCOME:

The students will be trained in the ethical values integral to the Technology-Humanities interface. Instead of becoming heartless technocrats, our students will be more sensitive and sympathetic to the weaker sections of the society and would develop a passion for social and environmental justice. Besides, they will develop creative faculties and respond to the burning issues of the contemporary world more effectively. The main objective of this course will be to kindle the latent wisdom in them which is intrinsically connected to the hunger for goodness.



FILM APPRECIATION

Course Code: HSMC (LMD-304)

In this course on film appreciation, the students will be introduced broadly to the development of film as an art and entertainment form. It will also discuss the language of cinema as it evolved over a century. The students will be taught as to how to read a film and appreciate the various nuances of a film as a text. The students will be guided to study film joyfully.

Theme - A: The Component of Films

- A-1: The material and equipment
- A-2: The story, screenplay and script
- A-3: The actors, crew members, and the director
- A-4: The process of film making... structure of a film

Theme - B: Evolution of Film Language

- B-1: Film language, form, movement etc.
- B-2: Early cinema... **silent film** (Particularly French)
- B-3: The emergence of feature films: **Birth of a Nation**
- B-4: Talkies

Theme - C: Film Theories and Criticism/Appreciation

- C-1: Realist theory; Auteurists
- C-2: Psychoanalytic, Ideological, Feminists
- C-3: How to read films?
- C-4: Film Criticism / Appreciation

Theme – D: Development of Films

- D-1: Representative Soviet films
- D-2: Representative Japanese films
- D-3: Representative Italian films
- D-4: Representative Hollywood film and the studio system

Theme - E: Indian Films

- E-1: The early era
- E-2: The important films made by the directors
- E-3: The regional films
- E-4: The documentaries in India

READING:

A Reader containing important articles on films will be prepared and given to the students. The students must read them and present in the class and have discussion on these.



LAW AND ENGINEERING
Course Code: HSMC (MME-303)

The aim of this course is to provide a basic understanding of the legal concepts and issues relevant to those wishing to practice as Engineers.

1. THE LEGAL SYSTEM: SOURCES OF LAW AND THE COURT STRUCTURE:

Enacted law -Acts of Parliament are of primary legislation, Common Law or Case law-Principles taken from decisions of judges constitute binding legal rules.

The Court System in India and Foreign Courtiers. (District Court, District Consumer Forum, Tribunals, High Courts, Supreme Court)

Arbitration: As an alternative to resolving disputes in the normal courts, parties who are in dispute can agree that this will instead be referred to arbitration.

2. BASIC PRINCIPLES OF CONTRACT LAW

3. SALE OF GOODS LAW

4. BUSINESS ORGANISATIONS:

SOLE TRADERS (Business has no separate identity from you, all business property belongs to you)

4.2. PARTNERSHIPS: There are three types of Partnerships: Limited Liability Partnership, General Partnership, Limited Partnerships

COMPANIES:

The nature of companies.

Classification of companies.

Formation of companies.

Features of a public company.

Carrying on business.

Directors–Their Powers and Responsibilities/Liabilities.

5. LAWS RELATING TO INDUSTRIAL POLLUTION, ACCIDENT, ENVIRONMENTAL PROTECTION, HEALTH AND SAFETY AT WORK.

6. PATENT LAW.

7. INFORMATION TECHNOLOGY LAW AND CYBER CRIMES.

8. LAW AND SOCIETY: INTERDISCIPLINARY NATURE OF LAW, LEGAL IDEOLOGIES/PHILOSOPHY/ SCHOOLS OF JURISPRUDENCE.

9. CONSTITUTIONAL LAW: THE SUPREME LAW OF THE LAND.

10. CASE STUDIES: IMPORTANT LEGAL DISPUTES AND JUDICIAL LITIGATIONS.



VIRTUAL LABORATORIES

(Engineering & Technology)

[January 2018]



ALL INDIA COUNCIL FOR TECHNICAL EDUCATION
Nelson Mandela Marg, Vasant Kunj, New Delhi 110 070



Virtual Laboratories: A New Way of Learning

It is said that in a professional life span of any engineering graduate, minimum three technological advances take place. Most of these advances are not part of the curriculum. On this background, it becomes essential to master “Learning to Learn” skill. Many options are now available for theory courses but laboratory work lacks in this. The laboratory/hands-on sessions are the backbone of engineering education. But in current situation, physical distances, costly equipment, and limited expertise often put constraints on performing experiments. The recent technological advances have addressed this problem. Now, it is possible to overcome these constraints by using web enabled experiments for remote operation so as to enthruse the curiosity and innovation of students.

Recently, MHRD has successfully completed two phases of project under NPTEL, to develop Virtual Labs through a consortium headed by IIT Delhi. During these phases, more than 180 labs were developed, comprising of more than 1700 experiments, in different domains of engineering. These experiments are field tested through various nodal centres across the country. The consortium members are, IIT Delhi, IIT Kanpur, IIT Bombay, IIT Madras, IIT Kharagpur, IIT Guwahati, IIT Roorkey, College of Engineering Pune, NITK Surathkal, Amrita University, Dayalbagh University, and IIIT Hyderabad.

The basic aim of this main project on Virtual Labs is to design and develop Virtual Labs in various areas of Science and Engineering, in order to benefit maximum number of students. The Virtual Labs are essentially comprising of a user-friendly graphical front-end, working in synchronization with a backend, consisting of a simulation-engine running on a server or actual measurement data or a remotely-triggered experiment. The Virtual Labs would cater to students at the undergraduate level, post graduate level as well as to research scholars. These Virtual Labs are centrally maintained and upgraded as and when required. It is expected that the competence level of the engineering students will enhance through the use of these labs. The Virtual Labs are expected to enthruse students about performing ‘experiments’ and thereby getting them interested in their respective disciplines in a meaningful way.

Physical distances and the availability of resources limit doing experiments, especially when they involve sophisticated instruments. Also, good teachers are always a scare resource. Web-based and video-based courses address the issue of teaching to some extent. Conducting joint experiments by two participating institutions and also sharing costly resources have always been a challenge. With the present-day internet and computer technologies the above limitations need not limit students and researchers in enhancing their skills. Also, in a country such as ours, costly instruments and equipment need to be shared with fellow researchers to the extent possible. Web enabled experiments can be designed for remote operation and viewing so as to enthruse the curiosity and innovation of students. This would help in learning basic and advanced concepts through remote experimentation. Today most equipment has a computer interface for control and data storage. It is possible to design good experiments around some of these equipment, which would enhance the learning of a student. Internet-based experimentation further permits use of resources – knowledge, software, and data available on the web, apart from encouraging skilful experiments being simultaneously performed at points separated in space (and possibly, time). The basic idea is to design and develop Virtual Labs in suitable areas of science and engineering in order to benefit the maximum number of students. An implicit objective is to enthruse students about performing ‘experiments’ and thereby getting them interested in their respective disciplines in a meaningful way. These activities would also generate an interest in the students to pursue higher studies/research. The virtual labs are designed in such a manner that maximum number of students can use these labs simultaneously.



Following is the list of discipline-wise Laboratories:

I. Electronics & Communication Engineering

S. No.	Name of the lab
1	Electronic design using DSP, FPGA, CPLD and Microcontrollers through simulation and direct access of the hardware
2	Digital Electronic Circuits Laboratory
3	Digital Signal Processing Laboratory
4	Speech Signal Processing Laboratory
5	Digital VLSI Design Virtual lab
6	Virtual Electric Circuits Laboratory
7	Fading Channels and Mobile Communications
8	Electromagnetic Theory
9	Signals and Systems Laboratory
10	Transducers and Instrumentation Virtual Laboratory
11	RF and Microwave Characterization Laboratory
12	Hybrid Electronics Lab
13	Queuing Networks Modeling Lab
14	Engineering Electro-magnets Laboratory
15	Virtual Microwave Lab
16	Basic Electronics
17	Single Board Heater System
18	Systems, communication and control laboratory for remote users

II. Civil Engineering

S. No.	Name of the lab
1	Soft Computing Tools in Engineering
2	Strength of Material Lab
3	Soil Mechanics & Foundation Engineering Lab
4	Fluid Mechanics Lab
5	Geotechnical Engineering Lab
6	Strength of Materials and Fluid Mechanics
7	Urban Transportation Systems Planning Lab
8	Surveying Lab
9	Basic Structural Analysis Lab
10	Virtual Smart Structures and Dynamics Lab

**III. Electrical Engineering**

S. No.	Name of the lab
1	Electrical Machines Lab
2	Electrical Machines Laboratory
3	Sensors Modeling & Simulation
4	Virtual Power Laboratory
5	Industrial Electric Drives And Substation Automation Lab
6	Industrial Automation Laboratory
7	Electrical Machines
8	Electronic instrumentation
9	PLC
10	Creative Design, Prototyping & Experiential Simulation Lab
11	Ergonomics Lab for Assessing Physical Aspects of Design
12	Real Time Embedded Systems Laboratory
13	Virtual Anthropology Lab
14	Electromechanical Energy Conversion Laboratory
15	Analog Signals, Network and Measurement Laboratory

IV. Biotechnology Engineering

S. No	Name of the lab
1	Virtual Proteomics Laboratory
2	System Biology Virtual Lab
3	Molecular Biology Virtual Lab I
4	Molecular Biology Virtual Lab II
5	Computer-Aided Drug Design Virtual Lab
6	Cell Biology Virtual Lab I
7	Cell Biology Virtual Lab I
8	Biological Image processing Virtual Lab
9	Virtual Immunology Lab I
10	Virtual Immunology Lab II
11	Virtual Population Ecology Lab I



S. No	Name of the lab
12	Virtual Population Ecology Lab II
13	Bioinformatics Virtual Labs I
14	Bioinformatics Virtual Labs II
15	Bioinformatics Virtual Labs III
16	Biochemistry Lab I
17	Biochemistry Lab II
18	Microbiology Lab I
19	Microbiology Lab II
20	Neurophysiology Lab
21	Neuron Simulation Virtual Lab
22	Ecology Virtual Lab
23	Biomedical Instrumentation
24	Medical Signal & Image Processing Lab
25	Bioreactor Modeling & Simulation lab
26	Biomedical and Signal processing Laboratory

V. Computer Science & Engineering

S. No.	Name of the lab
1	Data Structures Lab
2	Computer Programming Lab
3	Problem Solving
4	Principles of Programming Languages
5	Data Mining
6	Databases
7	Computer Organization
8	Software Engineering
9	VLSI
10	Digital Logic Design
11	Linux Lab
12	Speech Signal Processing
13	Mobile Robotics



S. No.	Name of the lab
14	Computer Graphics
15	Image Processing
16	Pattern Recognition
17	Artificial Neural Networks
18	Optical remote Sensing Lab
19	Computational Linguistics
20	Computer Architecture & Organization
21	Virtual Advanced VLSI Lab
22	Cryptography Lab
23	Analog CMOS VLSI Circuit Design Lab
24	Natural Language Processing Lab
25	Programming & Data Structure Lab
26	Advanced Network Technologies Lab
27	FPGA and Embedded System Lab

VI. Mechanical Engineering

S. No.	Name of the lab
1	Metal Forming and Solid Mechanics Lab
2	Vibration and Acoustics Lab
3	General Purpose Production Shop Simulation Lab
4	Laser Based Flow Diagnostics Laboratory
5	Micromachining laboratory
6	Fab laboratory
7	Mine Automation and Virtual Reality
8	Nanocomposite, fabrication and biomaterials laboratory & Signal Processing Laboratory
9	Material Response to Microstructural, Mechanical, Thermal and Biological Stimuli
10	Virtual Labs for Mechanical Vibrations
11	Mechanics of machine Lab
12	Machine dynamics & vibration lab
13	Virtual combustion and atomization laboratory

**VII. Physical Sciences**

S. No.	Name of the lab
1	Virtual Astrophysics Lab
2	Virtual Heat & Thermodynamics Lab
3	Virtual Advanced Mechanics Lab
4	Virtual Laser Optics Lab
5	Virtual Solid-State Physics Lab
6	Virtual Harmonic Motion & Waves Lab
7	Virtual Electricity and Magnetism Lab
8	Virtual Optics Lab
9	Virtual Modern Physics Lab
10	Virtual Lab on oscillations
11	Virtual Physical Sciences Lab
12	Virtual English and Communication

VIII. Chemical Engineering

S. No.	Name of the lab
1	Virtual Lab for Mass Transfer
2	Simulation of Control of Magnetic Levitation System
3	Process control, reaction engineering and unit operations lab Engineering
4	Chemical Engineering Lab

IX. Chemical Sciences

S. No	Name of the lab
1	Virtual Physical Chemistry Lab
2	Virtual Organic Chemistry Lab
3	Virtual Inorganic Chemistry Lab
4	Ultrafast Laser Spectroscopy
5	Molecular Florescence Spectroscopy
6	Molecular Absorption Spectroscopy
7	Quantum Chemistry
8	Colloidal and Surface Chemistry
9	Circular Dichroism Spectroscopy
10	Molecular Interactions Lab
11	Physical Chemistry Lab
12	Analytical Lab



How to Use the Virtual Laboratories

The virtual labs are easy to use. All the laboratories developed under “Virtual Laboratory” project is running from a central location. A student can visit the portal <https://vlabs.ac.in> and register for the laboratory he/she is interested in. These laboratories will have all the required information like aim, pre-test, theory, procedure, simulator, review questions, reference links, additional material to read, post-test, and feedback. This is one stop solution, and a student can run the simulator by following the procedure. The simulators are similar to experimental set-up or a brief presentation about the working of the model. In certain cases, a student need to load some software as pre-requisite. In case of any doubt or clarification a student can write to the lab developer through the portal only. It is expected that the engineering students to carry out these experiments prior to their actual experiment in certain cases. In case of non-availability of the sophisticated instruments/systems these experiments will fulfil the requirement of understanding the technology.

It would be a far enriching experience to use virtual labs and learn at one’s own pace and time. A student can even learn the skills which are not part of the curriculum but required as professionals to take up new challenges.

Appendix - A

A Guide to Induction Program

Introduction

In its 49th meeting, held on 14th March 2017, AICTE approved a package of measures for further improving the quality of technical education in the country. This 3-week mandatory Student Induction Program (SIP) based on Universal Human Values (UHV) is one of these key measures.

The SIP is intended to prepare newly admitted undergraduate students for the new stage in their life by facilitating a smooth transition from their home and school environment into the college and university environment.

The present form of the Student Induction Program (SIP) has taken inspiration from and gratefully acknowledges the many efforts in this direction. In particular the Foundation Program at IIT Gandhinagar¹ (July 2011) and the course in Universal Human Values and Professional Ethics² (IIIT Hyderabad, 2005; AKTU Lucknow, 2009 and PTU Jalandhar, 2011; overall about 35 universities); and also, the mentorship, internship and apprenticeship programs³ of several institutions. The SIP amalgamates all the three into an integrated whole, which leads to its high effectiveness in terms of building a healthy lifestyle, creativity, bonding and character. It develops sensitivity towards self and one's relationships, builds awareness about others and society beyond the individual, and also in bonding with their own batch-mates and senior students as well as faculty members.

The purpose of this document along with accompanying details are to help institutions / colleges in understanding the spirit of the Induction Program and implementing it.

It is in line with the thoughts expressed in the NEP 2020:

“Education is fundamental for achieving full human potential, developing an equitable and just society, and promoting National development”.

“The purpose of the education system is to develop good human beings capable of rational thought and action, possessing compassion and empathy, courage and resilience, scientific temper and creative imagination, with sound ethical moorings and values”.

“It aims at producing engaged, productive, and contributing citizens for building an equitable, inclusive, and plural society as envisaged by our Constitution”.

¹ IIT Gandhinagar places great emphasis on not only educating successful engineers of the future, but also creating well-rounded personalities, who contribute to society, are respectful of and can adapt to their surroundings, and prove themselves to be great thinkers and problem solvers in all avenues of life. In 2011, in line with this vision, It took the bold step to introduce a five week Foundation Program for incoming 1st year UG students. It involved activities such as games, art, etc.; also science and other creative workshops as well as lectures by eminent resource persons. To enable undivided attention on this, normal classes were scheduled only after this program was over.

² The foundation course was started in 2005 at IIIT Hyderabad. In 2009, UP Technical University (now AKTU) introduced it in all academic programs across their 550 colleges. From there on, it has been included in the curriculum of many universities, particularly in technical universities, in quite a natural manner, filling a long-felt need. After AKTU, it was IKG-Punjab Technical University in 2011, then Royal University of Bhutan in 2012 and so on. By 2020, more than 40 universities in India and both universities of Bhutan have been offering this foundation course. Since 2017, it has been a compulsory credit course in AICTE's model curriculum for all UG courses. Faculty from all departments are involved in conducting the course. The content is universal, rational, verifiable and leading to harmony. The mode is a self-exploration (and not sermonising or lecturing). Faculty are to be prepared beforehand. The results have been quite encouraging.

³ Many institutes setup mentor-mentee network under which 1st year students are divided into small groups, each assigned to a senior student as a Student Buddy, and to a faculty member as a Faculty Mentor. Thus, a new student has their guidance through regular interactions. They can discuss their aims and aspirations as well as concerns whether social, psychological, financial, academic, or otherwise.

“Education must build character, enable learners to be ethical, rational, compassionate, and caring, while at the same time prepare them for gainful, fulfilling employment”.

“The curriculum must include basic arts, crafts, humanities, games, sports and fitness, languages, literature, culture, and values, in addition to science and mathematics, to develop all aspects and capabilities of learners; and make education more well-rounded, useful, and fulfilling to the learner”.

So, when new students join an institution, they are to be welcomed and oriented to the institute, its vision, people, purpose, culture and values, policies, programs, rules and regulations etc. through a well-planned 3-week interaction before regular classes start.

Education aims at developing the students to their full potential, so that they are able to participate meaningfully not only in their profession, but also in their family, society and their natural environment. That requires the development of their values as well as skills.

Engineering colleges were established to train graduates in their respective branch/ department of study, be ready for the job market, but also have a holistic outlook towards life and have a desire and competence to work for national needs and beyond. The graduating student must have the knowledge and skills in the area of his study. However, s(he) must also have a broad understanding of society and relationships. Besides the above, several meta-skills and underlying values are needed. Character needs to be nurtured as an essential quality by which s(he) would understand and fulfil his/her responsibility as an engineer, a family member, a citizen etc.

The same applies to all other branches of study – be it professional, vocational or any other area of academic. The graduating student must be a good human being and have the skills in their area of study.

Each family, institution, region, community etc. have evolved their way of life, their cultures over a period of time. The new students are going from one culture to another. Today, a major issue is that one culture tends to be opposed to other cultures. This is because their basic assumptions, and therefore thoughts, are different. Even though there are commonalities at the core value level, the conflict is at the level of expression and details.

With this situation, it is imperative to

- Articulate the essence or core aspects of human culture and civilization, i.e. understand universal human values like trust and respect, love and compassion
- Appreciate the various expressions, different approaches taken in different regions

Our effort is in the context of the whole humanity. However, when it comes to exemplifying these essential concepts, we will have to take to local or national expressions.

In SIP, we want to provide an exposure to essence in the context of the whole humanity first. Then we can take a representative cross-section of all cultures as expressions of this essence. A yardstick to evaluate these various options is provided to guide the student towards a humanistic culture founded on the truth and universal human values like love and compassion.

For example: We want to live with fulfilment as a society. This part is common, universal. To exemplify this, we may expose students to traditional Indian culture and philosophy as well as contemporary western culture and thought.

The intent is:

- Connecting the basic principles through specific examples
- To see and appreciate various cultures, to see the commonality amongst them, in the light of clarity about human culture and civilisation.
- To evaluate any specific example, system or culture, with a view to fill the gaps, rather than to criticise or reject it. Further, we can also be mutually enriching for other cultures.

Student Induction Program (SIP)

With this background, the SIP has been formulated with specific goals to help students to:

- Become familiar with the ethos and culture of the institution (based on institutional culture and practices)
- Set a healthy daily routine, create bonding in batch as well as between faculty members and students
- Get an exposure to a holistic vision of life, develop awareness, sensitivity and understanding of the
Self---family---Society---Nation---International---Entire Nature
- Facilitate them in creating new bonds with peers and seniors who accompany them through their college life and beyond
- Overcome weaknesses in some essential professional skills – only for those who need it (e.g. Mathematics, Language proficiency modules)

The SIP consists of different activities which includes meeting new students, socializing with teachers and other people in the university. Secondly associating with the Local area or city, knowing different departments, associating with the department heads, local stores and necessary shops for the survival at new place. Basically, getting information about the rules and regulations of the university which includes do's and don'ts. Other activities which may involve students in several creative, cultural and co- curricular activities through which they can explore themselves and get idea about their intrinsic desires and interests which may help them in the long run. In order to make it worth, at the initial level of joining of student various seminars, lectures by eminent personalities, sessions by the appointed mentor for the student is being done to make them more familiar with the university environment. It has been seen that student after schooling when moves towards further studies for either under graduation or post-graduation has got so many confusions and false knowledge about the college and the curriculum. They should know the basic idea about the fruits and prospects of the particular course and the university or institute in which they are entering. To have faith about their choices and to know that after completion, they will be well equipped with the values and skills which may aid to their future goals and let them work for their personal motives, society and the Nation's development.

The various modules or core areas recommended for the 3-week SIP are:

SIP Module 1: Universal Human Values-I (UHV-I)

22 hours

The purpose is to help develop a holistic perspective about life. A self-reflective methodology of teaching is adopted. It opens the space for the student to explore his/her role (value) in all aspects of living – as an individual, as a member of a family, as a part of the society and as a unit in nature. Through this process of self-exploration, students are able to discover the values intrinsic in them. The session-wise topics are given below:

Session No.	Topic Title	Aspirations and Issues	Basic Realities (underlying harmony)
1	Welcome and Introductions	Getting to know each other	Self-exploration
2 and 3	Aspirations and Concerns	Individual academic, career... Expectations of family, peers, society, nation... Fixing one's goals	Basic human aspirations Need for a holistic perspective Role of UHV
4 and 5	Self-Management	Self-confidence, peer pressure, time management, anger, stress... Personality development, self-improvement...	Harmony in the human being
6 and 7	Health	Health issues, healthy diet, healthy lifestyle Hostel life	Harmony of the Self and Body

			Mental and physical health
8, 9, 10 and 11	Relationships	Home sickness, gratitude towards parents, teachers and others Ragging and interaction Competition and cooperation Peer pressure	Harmony in relationship Feelings of trust, respect... gratitude, glory, love
12	Society	Participation in society	Harmony in the society
13	Natural Environment	Participation in nature	Harmony in nature/existence
14	Sum Up	Review role of education Need for a holistic perspective	Information about UHV-II course, mentor and buddy
15	Self-evaluation and Closure	Sharing and feedback	

SIP Module 2: Physical Health and Related Activities

51 hours

This module is intended to help understand the basic principles to remain healthy and fit and practice them through a healthy routine which includes exercise, games etc.

SIP Module 3: Familiarization of Department/ Branch and Innovation 06 hours

This module is for introducing and relating the student to the institution/department/branch; how it plays a role in the development of the society, the state, region, nation and the world at large and how students can participate in it.

SIP Module 4: Visit to a Local Area

10 hours

To relate to the social environment of the educational institution as well as the area in which it is situated through interaction with the people, place, history, politics...

SIP Module 5: Lectures by Eminent People

06 hours

Listening to the life and times of eminent people from various fields like academics, industry etc. about careers, art, self-management and so on enriches the student's perspective and provides a holistic learning experience.

SIP Module 6: Proficiency Modules

06 hours

This module is to help fill the gaps in basic competency required for further inputs to be absorbed. It includes effort to make student proficient in interpersonal communication and expression as well as awareness about linguistic and thereafter NLP.

SIP Module 7: Literature / Literary Activities

30 hours

Through the exposure of local, national and international literature, this module is aimed at helping the student learn about traditional as well as contemporary values and thought.

SIP Module 8: Creative Practices

49 hours

This module is to help develop the clarity of humanistic culture and its creative, joyful expression through practice of art forms like dance, drama, music, painting, pottery, sculpture etc.

SIP Module 9: Extra Curricular Activities

06 hours

This is a category under which things that are not placed in any of the above may be placed. Some clubs and hobby group may be made for each of the above categories, so that students may pursue them even after SIP.

The recommended hours to be allocated are given above. Depending on the available faculty, staff, infrastructure, playgrounds, class timings, hostellers and day scholars etc., the timetable for these

activities may be drawn up. Of course, colleges may conduct an inaugural function at the beginning of the SIP; and they may also conduct a celebratory closing ceremony at the end of the SIP.

In particular, during the lockdown phase, appropriate care may be taken and some or all activities may be planned in distance-learning or on-line mode.

Sample 3-week Activity List

Week 1	Inaugural Function Regular SIP Activities (See Hours Plan)
Week 2	Regular SIP Activities (See Hours Plan)
Week 3	Regular SIP Activities (See Hours Plan) Valedictory and Closing Ceremony (Celebration)

Implementation

Every institution/college is expected to conduct the 3-week SIP under the guidance of the Director/Principal or Dean Students or a senior faculty member. For this, the institution is expected to make an SIP Cell / team, which will be responsible for planning, and then implementation of the SIP.

A UHV Cell is expected to be set up at each college and university. At the college, it will be managed by the UHV Convener / Coordinator under the chairpersonship of the director/principal. Faculty members and some students will be the members. They will coordinate the UHV activities like UHV-I during SIP, UHV-II, the faculty mentoring program and student buddy program throughout the student's association with the institute/college. The UHV Cell will work to incorporate human values in every aspect of education at the institute/college. Preparing UHV Faculty (Mentors) is one of its important activities.

Follow up

The SIP is only the beginning of the interaction with newly joined students.

An important part of the SIP is to associate one faculty mentor to every small groups of about 20 students; and also associate one senior student buddy to an even smaller groups of about 5 students for the guidance required for holistic development of the newly joined student throughout his/her time in the institution/college.

These activities are to be continued in the ongoing academic program along with other cultural activities through various student clubs which are largely be managed by students with the help of one or more faculty mentors. One of the main responsibilities of the faculty mentors would be helping the clubs to review their activities in alignment with human values.

Assessing the Implementation and Impact

The institution / college is expected to take feedback and prepare appropriate reports for assessing the impact and for further improvement of SIP. The basic feedback forms are included with the SIP Teaching Materials.

The SIP and its further follow up is expected to positively impact common graduate attributes like:

- Holistic vision of life
- Socially responsible behaviour
- Environmentally responsible work
- Ethical human conduct

Having Competence and Capabilities for Maintaining Health and Hygiene
Appreciation and aspiration for excellence (merit) and gratitude for all

AICTE will conduct periodic assessment to ascertain the implementation efforts and impact of the SIP and related activities.

Faculty Development

To ensure the implementation of SIP, and in particular to prepare the faculty, the National Coordination Committee for Student Induction (NCC-IP) has been formed. It offers various faculty development programs (FDPs) with the support from AICTE HQ and Regional Offices.

UHV Faculty (Mentors): Every institution is expected to prepare UHV Faculty in the ratio of 1:20 (1 faculty per 20 newly admitted students). Faculty from every teaching department are to be prepared. The basic preparation is participation in an 8-day FDP-SI (UHV).

Faculty for other Modules: Institutions/colleges generally have faculty, coaches, student clubs, alumni for these areas. FDP and comprehensive material will also be made available.

Student Activity Cell (SAC) – SIP Cell, UHV Cell and Fostering Unit

Student Activity Cell will have three cells or units:

- Fostering Unit – for coordinating various student clubs and activities in alignment with human values and IKS through various student clubs
- SIP Cell – for coordinating the annual SIP
- UHV Cell – for coordinating regular UHV activities, including UHV-I during SIP and UHV-II during future semesters, faculty mentoring and student buddy programs etc.



Each cell / unit will have some axis. E.g. the Fostering Unit will have 3 axis:

- UHV Axis – for UHV inputs and activities after the SIP
- Health Axis – for health oriented inputs and activities after SIP
- Career Axis – for career related inputs



Each axis will have one or more dimensions. E.g. the UHV Axis will have two dimensions:

- UHV Dimension
- Social Work Dimension



- Details of the clubs will be based on local conditions.

- Director or Principal or Dean of Student affairs will be the Chairman of Student Activity Cell
- SIP Cell (or Induction Unit) will be managed by faculty members with the help of student volunteers. 5 to 7 faculty members will be the members. The SIP Cell will be responsible for planning, organization, coordination and reporting of the annual Student Induction Program with the help of other faculty members and student volunteers
- UHV Cell will be managed by the UHV Convener / Coordinator under the chairpersonship of the director/principal. Faculty members and some students will be the members. They will coordinate the UHV activities like UHV-I during SIP, UHV-II 3rd/4th semester, faculty mentoring program and student buddy program throughout the student's association with the institute/college. UHV Cell will work to incorporate human values in every aspect of education at the institute/college. Preparing UHV Faculty (Mentors) is one of its activities
- Fostering unit will largely be managed by students with the help of one fostering unit faculty mentor. Student will be coordinators for axis, dimensions and clubs. Fostering unit will take support from induction unit as and when required. It will be responsible for coordinating various student clubs and activities in alignment with human values and Indian Knowledge System

SIP Teaching Material and More Details

The SIP Handbook as well as detailed guides and material for each of the modules is available on the AICTE website (<http://www.fdp-si.aicte-india.org/download.php>).

Details and Reference Documents:

1. G012 SIP Handbook v2
2. Teaching Material for UHV-I v2.1
3. Teaching Material for SIP modules 2 to 9 v1
4. G008 Facilitator (Mentor) Manual Version 2.1
5. G911 UHV Cell, Nodal and Resource Centres
6. G009 RP Development Process v2



· AICTE Recommended Books for Undergraduate Degree Courses as per Model Curriculum 2018

LIST OF SUGGESTED BOOKS OF INDIAN AUTHORS & PUBLISHERS

FOR

UNDERGRADUATE DEGREE COURSES IN

ENGINEERING & TECHNOLOGY [May 2018]



ALL INDIA COUNCIL FOR TECHNICAL EDUCATION
Nelson Mandela Marg, Vasant Kunj, New Delhi 110 070

www.aicte-india.org



FIRST YEAR

UNDERGRADUATE DEGREE COURSES

BASIC SCIENCE COURSES

List of Recommended Books:

BSC101 – Physics

1. Engineering Physics, Malik and Singh, Tata Mc Graw Hill
2. Engineering Physics, Naidu, Pearson
3. Mechanics, Mathur, S.Chand Publishing
4. Classical Mechanics, Upadhyaya, Himalaya Publishing House
5. Classical Mechanics, G. Aruldas, PHI
6. Engineering Physics, Gupta & Gaur, Dhanpat Rai
7. Quantum Mechanics, Ajay Ghatak S. Lokanathan, Trinity
8. Quantum Mechanics: A Text Book for undergraduates, Mahesh C Jain, TMH
9. Text Book of Ruantum Mechanics, M. Mathews & Venkatesan, TMH
10. Electromagnetic Theory, Prabir K. Basu & Hrishikesh Dhasmana, AneBooks
11. Fundamentals of Electromagnetic Theory, Khunita, PHI
12. A Text Book of Optics, Avadhanulu, S. Chand
13. Optics, Ajoy Ghatak, TMH
14. Modern Physics for Engineers, S.P. Taneja, R. Chand
15. The Physics of waves and Oscillations, N.K. Bajaj, TMH

BSC102 – Chemistry-I

1. Engineering Chemistry, Satyaprakash, Khanna Book Publishing, Delhi
2. A Text Book of Engg. Chemistry, Shashi Chawla, Dhanpat Rai & Co. (P) Ltd.
3. Essentials of Physical Chemistry, Bahl&Tuli, S.Chand Publishing
4. Applied Chemistry, Sunita Rattan, Kataria
5. Engineering Chemistry, Baskar, Wiley
6. Engineering Chemistry – I, D. Groukrishana, Vikas Publishing
7. Laboratory Manual Engg. Chemistry, Anupma Rajput, Dhanpat Rai & Co.

BSC103 – Mathematics – I

1. Advanced Engineering Mathematics, Chandrika Prasad, Khanna Book Publishing Co. (P) Ltd., Delhi (ISBN: 9789386173522)
2. Engineering Mathematics for first year, Veerarajan T., Tata McGraw-Hill
3. Higher Engineering Mathematics, Ramana B.V., Tata McGraw
4. Differential Calculus Shanti Narayan & Dr. P.K. Mittal, S.Chand Publishing
5. A Course & Mathematical Analysis (ISBN: 9788121904728), Narayan & Mittal, S.Chand
6. Elements of Mathematical Analysis, R.Agor, (ISBN: 9789382609599)
7. Integral Calculus Shanti Narayan & Dr. P.K. Mittal, (ISBN: 9788121906814), S.Chand
8. A Textbook of Matrices, Narayan & Mittal, (ISBN: 9788121925969), S.Chand
9. Advanced Engineering Mathematics (ISBN: 9788120336094), Sashtry, PHI
10. Engineering Mathematics – I, Reena Garg, Khanna Book Publishing



BSC103 – Mathematics – II

1. Advanced Engineering Mathematics, Chandrika Prasad, Khanna Book Publishing Co. (P) Ltd., Delhi
2. Higher Engineering Mathematics, Ramana B.V., Tata McGraw Hill
3. Advanced Engineering Mathematics (ISBN:9788120336094), Sashtry, PHI

ENGINEERING SCIENCE COURSES

List of Recommended Books:

ESC101 – Basic Electrical Engineering

1. Basic Electrical Engineering, Ritu Sahdev, (ISBN: 9789386173492), Khanna Book Publishing Co.
2. Basic Electric Engineering, DP Kothari & Nagrath, Tata McGraw Hill
3. Basic Electrical Engineering, Mittle & Mittal, Tata McGraw Hill
4. Basic Electric Engineering, DC Kulshrethra, Tata McGraw Hill

ESC102 – Engineering Graphics and Design

1. Engineering Graphics & Design, Jain, Maheshwary, Gautam, Khanna Publishing House
2. Engineering Drawing, ND Bhat, Charotar Publishing House
3. Engineering Drawing and Computer Graphics, Shah, Pearson
4. Textbook on Engineering Drawing, Narayana, Scitech Publishers
5. Engineering Graphics, Agarwal & Agarwal, TMH

ESC103 – Programming for Problem Solving

1. Programming in ANSI in C, E Balaguruswamy, Tata McGraw Hill
2. Computer Concepts and Programming in C, R.S. Salaria, Khanna Publishing
3. Let us C, Yashavant P. Kanetkar, BBP Publications, Delhi

HUMANITIES & SOCIAL SCIENCES

List of Recommended Books:

HSMC101 – English

1. Technical Communication, Meenakshi Raman & Sangeeta Sharma, Oxford University Press
2. Effective Communication Skills, Kulbushan Kumar, Khanna Publishing House, Delhi
3. Communication Skills, Pushplata, Sanjay Kumar, Oxford University Press



CIVIL ENGINEERING UNDERGRADUATE DEGREE COURSES

SEMESTER – III (SECOND YEAR)

List of Recommended Books:

ESC202 – Basic Electronics

1. Basic Electronics, Santiram Kal, Prentice Hall
2. Basic Electronics, BL Thareja, S.Chand Publishing
3. All-in-One Electronics Simplified, A.K. Maini, Khanna Book Publishing

ESC109 – Biology for Engineers

1. Biology for Engineers (ISBN: 9781121439931), TMH

ESC203 – Computer Aided Civil Engineering Drawing

1. Civil Engineering Drawing, Sharma & Gurucharan Singh, Standard Publishers
2. A Course in Civil Engineering Drawing, Sikka, S.K. Kataria & Sons
3. Engineering Drawing, Dhanarajay A Jolhe, Tata McGraw Hill

ESC205 – Engineering Mechanics

1. Engineering Mechanics, D.S. Bedi, Khanna Book Publishing Co. (P) Ltd., Delhi
2. Engineering Mechanics, R. S. Khurmi, S.Chand Publishing
3. A Textbook of Engineering Mechanics, R.K. Bansal, Laxmi Publications
4. Engineering Mechanics, Sharma, Pearson

ESC212 – Energy Science & Engineering

1. Energy Technology, OP Gupta, Khanna Book Publishing Co. (P) Ltd., Delhi
2. Energy Engineering & Management, Chakrabarti A, PHI

BSC225 – Life Science

1. Life Sciences, Vol-I, II, Pranav Kumar, Pathfinder Publication

BSC201 – Mathematics – III

1. Advanced Engineering Mathematics, Chandrika Prasad, (ISBN: 9789386173522) Khanna Book Publishing Co. (P) Ltd., Delhi
2. Higher Engineering Mathematics, Ramana B.V., Tata McGraw Hill
3. Advanced Engineering Mathematics (ISBN:9788120336094), Sashtry, PHI
4. Discrete Mathematics and Its Applications, S. Chakraborty & B.K. Sarkar, Oxford

HSMC251 – Introduction to Civil Engineering

1. Basic Civil Engineering, Palanichamy, McGraw Hill
2. Basic Civil Engineering, Satheesh Gopi, Pearson Publishers



SEMESTER – IV (SECOND YEAR)

List of Recommended Books:

ESC209 – Mechanical Engineering

1. Basic Mechanical Engineering, M.P. Poonia, S.C. Sharma & T.R. Banga, Khanna Publishing House
2. Basic Mechanical Engineering, G. Shanmugam & S Ravindran, Mc Graw Hill
3. Basic Mechanical Engineering, Pravin Kumar, Pearson

PCC-CE201 – Instrumentation & Sensor Technologies for Civil Engineering Applications

1. Electronics Measurements & Instrumentation, J.G. Joshi, Khanna Publishing House
2. A Course in Electronics Measurements and Instrumentation, A.K. Sahwney, Dhanpat Rai

PCC-CE202 – Engineering Geology

1. Text Book of Engineering Geology, N. Chenna Kesavulu, Macmillan Publishers
2. Engineering Geology for Civil Engineers, Varghese P.C, PHI
3. Engineering and General Geology, Parbin Singh, SK Kataria & Sons
4. Engineering Geology, Subinoy Gangopadhyay, Oxford University

PCC-CE203 – Disaster Preparedness & Planning

1. Disaster Management, S.C. Sharma, Khanna Publishing House
2. Disaster Management, Ghosh G.K., APH Publishing Corporation
3. Handbook of Disaster Management, Singh B.K., Rajat Publication
4. Disaster Management in India, A.K. Singh, New Royal Book Company

PCC-CE204 – Introduction to Fluid Mechanics

1. Fluid Mechanics, Sadhu Singh, Khanna Books, Delhi
2. Fluid Mechanics, RK Bansal, Laxmi Publications
3. Fluid Mechanics, Modi & Seth, Standard Publishers
4. Fluid Mechanics, Hydraulics and Hydraulic Machines, KR Arora, Standard Publishers Distributors

PCC-CE205 – Introduction to Solid Mechanics

1. Strength of Materials, D.S. Bedi, Khanna Publishing House
2. Strength of Materials, R Subramanian, Oxford University Press
3. Strength of Materials, RK Bansal, Laxmi Publications

PCC-CE206 – Surveying & Geomatics

1. Advanced Surveying, Madhu & Gobi, Pearson India
2. Geomatics Engineering, Arora & Badjatia, Nem Chand & Co.
3. Surveying Vol.-I, II, III, BC Punamia, Laxmi Publications
4. Surveying, Vol.-I, II, III, K.R. Arora, Standard Book House

PCC-CE206 – Materials, Testing & Evaluation

1. Highway Materials and Pavement, Khanna & Justo, Nemchand & Bros.

MC-CE207– Management – I (Organizational Behaviour)

1. A Textbook of Organizational Behaviour, CB Gupta, S.Chand Publications
2. Organizational Behaviour, LM Prasad, Sutan Chand and Sons



SEMESTER – V (THIRD YEAR)

List of Recommended Books:

PCC-CE301 – Mechanics of Materials

1. Structural Analysis, R. Agor, Khanna Publishing House
2. Mechanics of Materials, BC Punmia & A.K. Jain, Laxmi Publications

PCC-CE302 – Hydraulic Engineering

1. Fluid Mechanics & Hydraulic Machines, SS Rattan, Khanna Publishing House
2. Hydraulic and Fluid Mechanics, PN Modi & SM Seth, Standard Book House
3. Fluid Mechanics, Dr K Subramanya, TMH
4. Fluid Mechanics and Machinery, CSP Ojha, R Berndtsson & P.N. Chandramouli, Oxford University
5. Fluid Machinery, Sadhu Singh, Khanna Publishing House, Delhi

PCC-CE303 – Structural Engineering

1. Advanced Structural Analysis, A.K. Jain, Nem Chand Bros.
2. Prestressed Concrete, Srikant B. Vanakudre, Khanna Publishing House
3. Design of Prestressed Concrete, Krishnan Raju, Tata McGraw Hill
4. Design of Steel Structures, N. Subramanian, Oxford University Press
5. Reinforced Concrete Vol. II, H.J. Shah, Charotar Publications
6. Structural Analysis, R. Agor, Khanna Publishing House

PCC-CE304 – Geotechnical Engineering

1. Principles of Geotechnical Engineering, Braja Das, Cengage
2. Basic and applied Soil Mechanics, Rajan & Rao, New Age International Publishers
3. Soil Mechanics & Foundation Engineering, Arora KR, Standard Publishers

PCC-CE305 – Hydrology & Water Resources Engineering

1. Engineering Hydrology, Subramanayan, McGraw Hill
2. Applied Hydrology, KN Muthreja, McGraw Hill

PCC-CE306 – Environmental Engineering

1. Environmental Engineering, S.C. Sharma, Khanna Publishing House
2. Basic Environmental Engineering, R.C. Gaur, Newage Publications
3. Water Resources Engineering, PN Modi, Standard Publishers
4. Environmental Engineering, Dr. AK Jain (ISBN: 978-93-86173560), Khanna Publishers
5. Irrigation Water Power & Water Resource Engineering, Arora, Standard Publishers

PCC-CE307 – Transportation Engineering

1. Transportation Engineering, L.R. Kadiyali, (ISBN: 978-93-82609-85-8), Khanna Book Publishing
2. Principles of Transportation Engineering, Chakrobarty, PHI Learning
3. Highway Engineering, Khanna & Justo, Nemchand & Bros.
4. Principles of Transportation Engineering, Partha Chakraborty, PHI Learning

HSMC255 – Professional Practice, Law & Ethics

1. A Foundation Course in Human Values and Professional Ethics, R.R. Gaur, R. Sangal, G.P. Bagaria, Excel Books, Delhi
2. Professional Ethics and Human Values, Premvir Kapoor, Khanna Book Publishing



MC-1 – Constitution of India

1. Introduction to Constitution of India, D.D. Basu, Lexis Nexus
2. The Constitution of India, PM Bhakshi, Universal Law

SEMESTER – VI (THIRD YEAR)

List of Recommended Books:

PCC-CE308 – Construction Engineering & Management

1. Construction Engineering & Management, S.C. Sharma & S.V. Deodhar, Khanna Book Publishing
2. Construction Project Management, Jha, Pearson
3. Building Construction, Varghese PC, Prentice Hall India

PCC-CE309 – Engineering Economics, Estimation & Costing

1. Estimating and Costing in Civil Engineering, BN Dutta, UBS Publishers
2. Estimating, Costing Specifications & Valuation, M Chakraborty
3. Handbook of Construction Management, Joy PK, , Macmillan

List of Some Other Useful Books:

1. Concrete: Microstructure, Properties & Materials, PK Mehta, Tata McGraw
2. Air Pollution Control Engineering, Keshav Kant, Khanna Publishing House
3. Design of Bridge Structures, T.R. Jagadeesh & M.A. Jayaram, Phi
4. Project Management with CPM /PERT, Punmia, Laxmi Publications
5. Introductory Methods of Numerical Analysis, Sashtry, PHI
6. Basics of Remote Sensing & GIS, S. Kumar, University Sc. Press
7. Theory of Structures, Punmia, Laxmi Publications
8. Civil Engineering Construction Materials, S.K. Sharma, KBP House
9. Ground Improvement Techniques, Purushottam Raj, Tata McGraw Hill
10. Elements of Land/Soil Pollution, O.P. Gupta, Khanna Publishing House
11. Water Supply and Sanitary Engineering, Rangwala, Charotar Publications
12. Harbour, Dock and Tunnel Engineering, Srinivasan, Charotar Publications
13. Airport Engineering, Rangwala, Charotar Publications



ELECTRICAL ENGINEERING UNDERGRADUATE DEGREE COURSES

SEMESTER – III (SECOND YEAR)

List of Recommended Books:

PCC-EE01 – Electrical Circuit Analysis

1. Networks and Systems, Asfaq Hussain, Khanna Publishing House, Delhi
2. Networks and systems, D. Roy Choudhary, New Age International Publishers
3. Problems and Solutions of Electrical Circuit Analysis, R.K. Mehta & A.K. Mal, CBS Publishers

PCC-EE02 – Analog Electronics

1. Analog Electronics, L.K.Maheshwari, Laxmi Publications
2. Analog Electronics, A.K. Maini, Khanna Publishing House
3. Analog Electronics, I.G.Nagrath, PHI

PCC-EE04 – Electrical Machines - I

1. Electrical Machines-I, GC Garg, (ISBN: 978-93-86173-447), Khanna Book Publishing, Delhi
2. Electrical Machines, Kothari & Nagrath, TMH
3. Electrical Machines, Mehta & Mehta, S.Chand Publications

ESC201 – Engineering Mechanics

1. Engineering Mechanics, D.S. Bedi, Khanna Book Publishing Co. (P) Ltd.
2. Engineering Mechanics, R.S. Khurmi, S.Chand Publishing
3. A Textbook of Engineering Mechanics, R.K. Bansal, Laxmi Publications
4. Engineering Mechanics, Sharma, Pearson

SEMESTER – IV (SECOND YEAR)

List of Recommended Books:

PCC-EE07 – Digital Electronics

1. Digital Electronics, A. Anand Kumar, PHI
2. Modern Digital Electronics, R.P. Jain, TMH
3. Digital Electronics, R.Anand Khanna Publishing House

PCC-EE09 – Electrical Machines - II

1. Electrical Machines - II, GC Garg, (ISBN: 978-93-86173-60-7), Khanna Book Publishing, Delhi
2. The Performance & Design of Alternating Current Machines, Say, CBS Publishers
3. Principle of Electrical Machine Design with Computer Programs, S.K. Sen, Oxford & IBH

PCC-EE11 – Power Electronics

1. Modern Power Electronics, P.C. Sen., Chand & Co.
2. Power Electronics, V.R.Moorthi, Oxford University Press
3. Power Electronics, Muhammad H. Rashid, Pearson



PCC-EE13 – Signals and Systems

1. Signals and Systems, A. Anand Kumar, Phi
2. Signals and Systems, Rishabh Anand, Khanna Book Publishing Co., Delhi
3. Signals and Systems, Tarun Rawat, Oxford University Press
4. Signal Processing and Linear Systems, B.P. Lathi, Oxford University Press
5. Signals and Systems, J. Nagrath, S. N. Sharan, R. Ranjan, S. Kumar, TMH

BSC201 – Mathematics - III

1. Advanced Engineering Mathematics, Chandrika Prasad, Khanna Book Publishing Co. (P) Ltd., Delhi
2. Higher Engineering Mathematics, Ramana B.V., Tata McGraw Hill
3. Advanced Engineering Mathematics (ISBN:9788120336094), Sashtry, PHI
4. Discrete Mathematics and Its Applications, S. Chakraborty & B.K. Sarkar, Oxford

SEMESTER – V (THIRD YEAR)

List of Recommended Books:

PCC-EE14 – Power Systems – I

1. Modern Power System Analysis, Kothari Nagrath, Springer Verlag Publishers
2. Power System Operation and Control, S. Sivanagaraju & G. Sreenivasan, Pearson
3. Electrical Power Systems, C.L. Wadhwa, Newage Publishers

PCC-EE16 – Control Systems

1. Control System Engineering, Nagrath & Gopal, Newage Publishers
2. Control Systems, Ambikapathy, Khanna Book Publishing Co. (P) Ltd., Delhi

PCC-EE17 – Microprocessors

1. Microprocessors, Ramesh Gaonkar, Penram Publications
2. Advanced Microprocessors and Peripherals, Burchandi, TMH
3. Advanced Microprocessors, AK Gautam, Khanna Publishing House

SEMESTER – VI (THIRD YEAR)

List of Recommended Books:

PCC-EE20 – Power Systems – II

1. Modern Power System Analysis, Kothari Nagrath, Springer Verlag Publishers
2. Power System Operation and Control, Sivanagaraju & Sreenivasan, Pearson
3. Electrical Power Systems, C.L. Wadhwa, Newage Publishers

List of Recommended Books for Elective Courses:

1. Electromagnetic Waves, Shevgaonkar, R, McGraw Hill
2. Electrical Power Generation, Transmission and distribution, Singh, PHI
3. Electrical Power Generation, Tanmoy Deb, Khanna Publishers
4. HVDC Power Transmission System, K. R. Padiyar, Wiley
5. Introduction to Fuzzy Logic using MATLAB, S. N. Sivanandam, S. Sumati & S. N. Deepa, Springer
6. High Voltage Engineering, C.L. Wadhwa, Newage Publishers
7. Introduction to Neural Networks using MATLAB, Sivanandam, TMH
8. Electric Drives, N.K. De & P.K. Sen, PHI
9. Fundamentals of Electrical Drives, Dubey, Narosa Publishing House



MECHANICAL ENGINEERING UNDERGRADUATE DEGREE COURSES

SEMESTER – III (SECOND YEAR)

List of Recommended Books:

BSC201 – Physics -II

1. Engineering Physics, Garg & Singh
2. Mechanics, Mathur, S.Chand Publishing
3. Classical Mechanics, Upadhyaya, Himalaya Publishing House
4. Classical Mechanics, G. Aruldas, PHI
5. Engineering Physics, Gupta & Gaur, Dhanpat Rai
6. Quantum Mechanics, Ajay Ghatak S. Lokanathan, Trinity
7. Quantum Mechanics: A Text Book for undergraduates, Mahesh C Jain, TMH
8. A text Book of Ruantum Mechanics, M. Mathews & K. Venkatesan, TMH
9. Electromagnetic Theory, Prabir K. Basu & Hrishikesh Dhasmana, Ane Books
10. Fundamentals of Electromagnetic Theory, Khunita, PHI
11. A Text Book of Optics, Avadhanulu, S. Chand
12. Optics, Ajoy Ghatak, TMH
13. Modern Physics for Engineers, S.P. Taneja, R. Chand
14. The Physics of waves and Oscillations, N.K. Bajaj, TMH

BSC202 – Mathematics - III

1. Advanced Engineering Mathematics, Chandrika Prasad, Khanna Book Publishing Co. (P) Ltd., Delhi
2. Higher Engineering Mathematics, Ramana B.V., Tata McGraw Hill
3. Advanced Engineering Mathematics (ISBN:9788120336094), Sashtry, PHI
4. Discrete Mathematics and Its Applications, S. Chakraborty & B.K. Sarkar, Oxford

ESC201 – Basic Electronics Engineering

1. Basic Electronics, Santiram Kal, Printice Hall
2. Basic Electronics, B.L. Thareja, S.Chand Publishing
3. Basic Electronics, S. Biswas, Khanna Publications

ESC202 – Engineering Mechanics

1. Engineering Mechanics, D.S. Bedi, Khanna Book Publishing Co. (P) Ltd.
2. Engineering Mechanics, R.S. Khurmi, S.Chand Publishing
3. A Textbook of Engineering Mechanics, R.K. Bansal, Laxmi Publications
4. Engineering Mechanics, DP Sharma, Pearson

PCC-ME201– Thermodynamics

1. Engineering Thermodynamics, P.K. Nag, Tata McGraw Hill
2. Basic and Applied Thermodynamics, P.K. Nag, Tata McGraw Hill



SEMESTER – IV (SECOND YEAR)

List of Recommended Books:

PCC-ME202– Applied Thermodynamics

1. Engineering Thermodynamics, Nag P.K, Tata McGraw Hill
2. Basic and Applied Thermodynamics, PK Nag, Tata McGraw Hill

PCC-ME203– Fluid Mechanics and Fluid Machines

1. Fluid Mechanics, Sadhu Singh, Khanna Publishing House, Delhi
2. Fluid Mechanics, Modi & Seth, Standard Publishers

PCC-ME204– Strength of Materials

1. Strength of Materials, D.S. Bedi, Khanna Publishing, Delhi
2. Strength of Materials, R.K. Rajput, Laxmi Publications
3. Strength of Materials, R. Subramanian, Oxford Publications

PCC-ME205– Materials Engineering

1. Engineering Materials Properties and Selection, Budinski and Budinski, PHI
2. Material Science & Engineering, R. Balasubramanium, Wiley India

MC - II– Environmental Science

1. Textbook of Environmental Studies, Erach Bharucha, University Press
2. Environmental Studies, MP Poonia & SC Sharma, Khanna Publishing House
3. Environmental Studies, Rajagopalan, Oxford University Press

SEMESTER – V (THIRD YEAR)

List of Recommended Books:

PCC-ME301– Heat Transfer

1. Fundamental of Heat and Mass Transfer, M.Thirumaleshwar, Pearson
2. Computational Heat Transfer and Fluid Flow, Murlidhar & Sunder Rajan, Narosa
3. Thermal Engineering, M.L. Mathur & F.S. Mehta, Jain Publications
4. A Course in Heat & Mass Transfer, V.M. Domkundwar, Dhanpat Rai & Co.

PCC-ME302– Solid Mechanics

1. Strength of Materials, D.S. Bedi, Khanna Publishing House
2. Strength of Materials, R Subramanian, Oxford University Press
3. Strength of Materials, RK Bansal, Laxmi Publications
4. Mechanics of Materials, Punmia, Jain and Jain, Laxmi Publications

PCC-ME304– Kinematics & Theory of Machines

1. Theory of Machines, SS Rattan, Tata McGraw Hill
2. Kinematics & Theory of Machines, Sadhu Singh, Pearson



SEMESTER – VI (THIRD YEAR)

List of Recommended Books:

PCC-ME307– Manufacturing Technology

1. Manufacturing Technology, Vol. 1, 2, 3, PN Rao, TMH
2. Manufacturing Technology, RK Rajput, Laxmi Publications
3. Production and Operations Management, S.N.Chary, TMH

PCC-ME308– Design of Machine Elements

1. Machine Design (ISBN: 9789382609575), Sadhu Singh, Khanna Publishing House, Delhi
2. Machine Design Data Book, Sadhu Singh, Khanna Publishing House
3. Design Data Book, Mahadevan, CBS Publishers & Distributors
4. Introduction to Machine Design, V.B. Bhandhari, McGraw Hill
5. A Textbook of Machine Design, RS Khurmi, S.Chand Publications

SEMESTER – VII (FOURTH YEAR)

List of Recommended Books:

PCC-ME401– Automation in Manufacturing

1. Modern Machining Process, Pandey and Shan, TMH
2. Manufacturing Automation Metal Cutting Mechanics, Machine Tool Vibrations, CNC Design, Yusuf, Cambridge University Press

List of Recommended Books for Other Courses:

Mechatronics

1. A Textbook of Mechatronics, RK Raput, S.Chand Publishing
2. Mechatronics: Principles, Concepts and applications, Mahalik N.P, Tata McGraw Hill
3. Introduction to Mechnotronics, Kuttan, Oxford University

Finite Element Analysis

1. A Text Book of Finite Element Analysis, Seshu, Phi
2. The Finite Element Methods in Engineering, SS Rao, Butterworth
3. An Introduction to Finite Element Methods, J Reddy, Tata McGraw Hill

Power Plant Engineering

1. Power Plant Engineering, P.K. Nag, TMH
2. Power Plant Engineering, S.C. Sharma, Khanna Publications

Refrigeration and Air Conditioning

1. Refrigeration and Air Conditioning, C.P. Arora, TMH
2. Refrigeration and Air Conditioning, Sadhu Singh, Khanna Publishing House
3. A Course in Refrigeration & Air Conditioning, Domkundwar, Dhanpat Rai

Machine Drawing

1. Machine Drawing, PS Gill, Katsons
2. Machine Drawing, O.P Jahkar, Amit Mathur, Khanna Publishing House



Gas Turbines

1. Gas Turbines, Ganeshan, Tata McGraw Hill
2. Internal Combustion Engines, Mathur & Sharma, Dhanpat Rai
3. Steam, Gas Turbine and Power Plant Engineering, Yadav, CPH, Allahabad

Total Quality Management

1. Total Quality Management, Poonia & Sharma, Khanna Publishing House
2. Total Quality Management, Gopal, PHI

Engineering Management

1. Engineering Management: Industrial Engineering & Management, SC Sharma, Khanna Publishing House, Delhi
2. Industrial Engineering & Operations Management, SK Sharma

Automobile Engineering

1. Automotive Engineering, Kirpal Singh, Standard Publishers
2. Automobile Mechanics, A.K. Babu & S.C. Sharma, T.R. Banga, Khanna Book Publishing
3. Automotive Electricals and Electronics, A.K. Babu, Khanna Publishing House
4. A Textbook of Automobile Engineering, R.K. Rajput, Laxmi Publications

Reliability Engineering

1. Reliability Engineering, E. Balaguruswamy, Tata McGraw Hill
2. Reliability Engineering, L.S. Srinath, Affiliated East-West Press
3. Industrial Maintenance Management, S.K. Srivastava, S.Chand & Co.

List of Some Other Useful Books:

1. Robotics and Control, Mittal & Nagrath, Tata McGraw Hill
2. Robotics Technology, Satyarajan Deb, TMH
3. Practical Non-Destructive Testing, Baldev Raj, T. Jay Kumar, M. Thavasimuthu, Narosa
4. Mechanical Vibrations, S.S. Rao, Addison Wesley Longman
5. Principles and Practice of Management, Prasad, L.M, Sultan Chand
6. Mechanical Vibrations, SS Rao, Pearson
7. Mechanical Vibrations, GK Grover, Nem Chand Bros.
8. Transducers and Instrumentation, V.S. Murthy, PHI
9. Transducers and Instrumentation, Nakra & C.Houdhary, TMH
10. Fundamentals of Industrial Drives, Sarkar, PHI
11. Automotive Engines, A.K. Babu, Khanna Publications
12. Modern Machining Process, Pandey & Shan, Tata McGraw Hill



COMPUTER SCIENCE ENGINEERING UNDERGRADUATE DEGREE COURSES

SEMESTER – III (SECOND YEAR)

List of Recommended Books:

ESC201 – Analog Electronic Circuits

1. Analog Electronics, L.K. Maheshwari, Laxmi Publications
2. Analog Electronics, A.K. Maini, Khanna Publishing House
3. Analog Electronics, I.G. Nagrath, PHI

PCC-CS301 – Data Structures & Algorithms

1. Fundamentals of Data Structures, Sartaj Sahni, University Press
2. Data Structures, RS Salaria, Khanna Publishing House
3. Data Structures through C, Yashwant Kanetkar, BPB Publications
4. Expert Data Structures with C++, RB Patel, Khanna Publications

ESC302– Digital Electronics

1. Digital Electronics, A. Anand Kumar, PHI
2. Modern Digital Electronics, R.P. Jain, TMH
3. Digital Electronics, Rishabh Anand, Khanna Publishing House

BSC301 – Mathematics – III

1. Advanced Engineering Mathematics, Chandrika Prasad, Khanna Book Publishing Co. (P) Ltd., Delhi
2. Higher Engineering Mathematics, Ramana B.V., Tata McGraw
3. Higher Engineering Mathematics, Ramana B.V., Tata McGraw Hill
4. Advanced Engineering Mathematics (ISBN:9788120336094), Sashtry, PHI

SEMESTER – IV (SECOND YEAR)

List of Recommended Books:

PCC-CS401 – Discrete Mathematics

1. Discrete Mathematics and Its Applications, Chakraborty & Sarkar, Oxford
2. Discrete Structures, S.B. Singh, Khanna Book Publishing, Delhi
3. Discrete Mathematics, T. Veerarajan, Tata McGraw-Hill

PCC-CS402– Computer Organization & Architecture

1. Computer Fundamentals Architecture and Organization, B. Ram, New Age International
2. Computer Organization & Architecture, Rajaraman, PHI Learning

PCC-CS403 – Operating Systems

1. Operating Systems, Ekta Walia, Khanna Publishing House, Delhi
2. Operating Systems A Concept-Based Approach, Dhananjay M. Dhamdhare, McGraw Hill



PCC-CS404– Design & Analysis of Algorithms

1. Design & Analysis of Algorithms, S. Sridhar, Oxford
2. Design & Analysis of Algorithms, Sharma, Khanna Publishing House, N.Delhi

HSMC401 – Management – I

1. A Textbook of Organizational Behaviour, CB Gupta, S.Chand Publications
2. Organizational Behaviour, LM Prasad, Sultan Chand and Sons

MC – Environmental Sciences

1. Textbook of Environmental Studies, Erach Bharucha, University Press
2. Environmental Studies, MP Poonia & SC Sharma, Khanna Publishing House
3. Environmental Studies, Rajagopalan, Oxford University Press

SEMESTER – V (THIRD YEAR)

List of Recommended Books:

ESC501 – Signals and Systems

1. Signals and Systems, A. Anand Kumar, Phi
2. Signals and Systems, Tarun Rawat, Oxford University Press
3. Signals and Systems, Rishabh Anand, Khanna Book Publishing Co., Delhi
4. Signal Processing and Linear Systems, B.P. Lathi, Oxford University Press
5. Signals and Systems, J. Nagrath, S. N. Sharan, R. Ranjan, S. Kumar, TMH

PCC-CS501- Database Management Systems

1. Fundamental of Database Systems, E. Ramez and Navathe, Pearson
2. Database Management Systems, R.P. Mahapatra & Govind Verma, Khanna Publishing House
3. Database Management Systems, Raghurama Krishan, McGraw Hill

PCC-CS502 - Formal Language & Automata Theory

1. Theory of Computer Science: Automata, Languages and Computation, Mishra, Phi
2. Theory of Computation, RB Patel & Prem Nath, Khanna Publications

PCC-CS503 - Object Oriented Programming

1. Object Oriented Programming with C++, Balaguruswamy, TMH
2. Mastering Object-Oriented Programming with C++, R.S. Salaria, Khanna Book Publishing, N.Delhi
3. Programming with Java, Balaguruswamy, TMH
4. Object Oriented Programming in C++ and Java, D.Samantha, PHI
5. Internet and Java Programming, Tanweer Alam, Khanna Publishing House

MC- Constitution of India

1. Introduction to Constitution of India, D.D. Basu, Lexis Nexis
2. The Constitution of India, PM Bhakshi, Universal Law

SEMESTER – VI (THIRD YEAR)

List of Recommended Books:



PCC-CS602 - Computer Networks

1. Computer Networks, M. Dave, Cengage
2. An Engineering Approach to Computer Networking, Keshav, Pearson
3. An Integrated Approach to Computer Networks, Bhavneet Sidhu, Khanna Publications
4. Telecommunication Switching System and Networks, Viswanathan, PHI

List of Recommended books for Additional Courses:

Graph Theory

1. Graph Theory, Deo and Narsingh, PHI Publications
2. Combinatorics & Graph Theory, Singh, Khanna Publishing House

Software Engineering

1. A concise introduction to software Engineering, Pankaj Jalote, Springer
2. Software Engineering, Nasib Singh Gill, Khanna Publishing House
3. Software Engineering, K.K. Aggarwal & Yogesh Singh, New Age International

Python Programming

1. Taming Python by Programming, Jeeva Jose, Khanna Publishing House
2. Introduction to Computing and Problem Solving with Python, J. Jose, Khanna Publications
3. Python Programming, Seema Thareja, Pearson

Artificial Intelligence

1. A classical approach to Artificial Intelligence, Munesh Chandra Trivedi, Khanna Publications
2. Artificial Intelligence and Machine Learning, Chandra S.S. & H.S. Anand, PHI Publications
3. Machine Learning, Rajiv Jain, Khanna Publishing House

Cryptography & Network Security

1. Cryptography & Network Security, Atul Kahate, McGraw Hill
2. Cryptography & Network Security, V.K. Jain, Khanna Publishing House

Internet of Things

1. Internet of Things, Jeeva Jose, (ISBN: 978-93-86173-591) KBP House
2. Internet of Things, Arsheep Bahga and Vijay Madisetti

Software Testing

1. Software Testing, Yogesh Singh, University Press
2. Fundamentals of Software Testing, AB Mathur, Pearson
3. Software Testing Principles and Practices, Chauhan, Oxford University Press

Data Analytics

1. Big Data & Hadoop, V.K. Jain, Khanna Publishing House
2. Big Data Black Book, DT Editorial Services, Wiley India
3. Data Science & Analytics, V.K. Jain, Khanna Publishing House
4. Beginner's Guide for Data Analysis using R Programming, (ISBN: 978-93-86173454), Jeeva Jose

Numerical Methods

1. Numerical Methods, E.Balaguruswamy, TMH
2. Introductory Methods of Numerical Analysis, S.S.Sastry, PHI
3. Computer Oriented Numerical Methods, R.S. Salaria, Khanna Publishing House



List of Some Other Useful Books:

1. Information Systems Security, Nina Godbole, Wiley
2. Introduction to Embedded Systems, K.V. Shibu, McGraw Hill
3. Introduction to Embedded Systems, Raj Kamal, Tata McGraw Hill
4. Fundamentals of Computers, Ravichandran, Tata McGraw Hill
5. Fundamentals of Computers, Rajaraman, PHI
6. Computer Fundamentals and Programming in C, Nasib Singh Gill, KBP
7. Hacking, Harsh Bothra, Khanna Publishing House
8. Cryptography and Information Security, V. K. Pachghare, PHI Learning
9. Information Security & Cyber Laws, Gupta, Khanna Publishing House
10. Ad hoc Wireless Networks Architectures, C.Siva Ram Murthy, Pearson
11. Multimedia Systems Concepts Standards and Practices, Ramesh, PHI
12. Multimedia and Animation, V.K. Jain
13. Information Theory, R Ash, Dover Science Publications
14. Essentials of Cloud Computing, K. Chandrasekaran
15. Cloud Computing, Pandey & Choudhary



ELECTRONICS & COMMUNICATION ENGINEERING UNDERGRADUATE DEGREE COURSES

SEMESTER – III (SECOND YEAR)

List of Recommended Books:

EC01 – Electronic Devices

1. Solid State Electronic Devices, G. Streetman, and S. K. Banerjee, Pearson
2. Semiconductor Physics and Devices, D. Neamen, D. Biswas, McGraw Hill
3. All-in-One Electronic Simplified, A.K. Maini, Khanna Publishing House

EC03 – Digital System Design

1. Modern Digital Electronics, RP Jain, TMH
2. Digital System Design using VHDL, R. Anand, Khanna Publishing House
3. A VHDL Primer, Bhaskar, Pearson
4. A VHDL Synthesis, Bhaskar, Pearson

EC05 – Signals and Systems

1. Signals and Systems, A. Anand Kumar, Phi
2. Signals and Systems, Tarun Rawat, Oxford University Press
3. Signals and Systems, Rishabh Anand, Khanna Book Publishing Co., Delhi
4. Signal Processing and Linear Systems, B.P. Lathi, Oxford University Press
5. Signals and Systems, J. Nagrath, S. N. Sharan, R. Ranjan, S. Kumar, TMH

EC05 – Network Theory

1. Networks and Systems, Asfaq Hussain, Khanna Publishing House, Delhi
2. Circuits and Network, Sudhakar & Shyammohan, Tata McGraw-Hill
3. Networks and systems, D. Roy Choudhary, New Age International Publishers

SEMESTER – IV (SECOND YEAR)

List of Recommended Books:

EC07 – Analog & Digital Communication

1. Analog & Digital Communication, B.P. Lathi, Gupta, Oxford University Press
2. Analog & Digital Communications, Debajani Mitra, TMH
3. Digital Design, Natrajan Ananda, PHI Publications

EC09 – Analog Circuits

1. Analog Electronics, L.K. Maheshwari, Laxmi Publications
2. Analog Electronics, A.K. Maini, Khanna Publishing House
3. Analog Electronics, I.G. Nagrath, PHI



EC11 – Microcontrollers

1. R. S. Gaonkar, Microprocessor Architecture: Programming and Applications with the 8085/8080A, Penram International Publishing
2. Microprocessors and Microcontrollers, Krishna Kant, PHI
3. 8051 Microcontrollers, Rajakamal, TMH

SEMESTER – V (THIRD YEAR)

List of Recommended Books:

EC13 – Electromagnetic Waves

1. Electromagnetic Waves, R.L. Yadav, Khanna Publishing House
2. Electromagnetic Waves, R.K. Shevgaonkar, Tata McGraw Hill India
3. Engineering Electromagnetics, Narayana Rao, PHI

EC15 – Computer Architecture

1. Computer Fundamentals Architecture and Organization, B. Ram, New Age
2. Computer Organization & Architecture, Rajaraman, PHI Learning

EC17 – Digital Signal Processing

1. Digital Signal Processing, S. Salivahanan, McGraw Hill
2. Digital Signal Processing, S.K. Mitra, TMH
3. Digital Signal Processing, Ashok Ambardar, Cengage
4. Digital Signal Processing, A. Anand Kumar, PHI

SEMESTER – VI (THIRD YEAR)

List of Recommended Books:

EC19 – Control Systems

1. Control Systems, Gopal, Tata McGraw-Hill
2. Modern Control Engineering, Nagrath & Gopal, New Age International
3. Control Systems, A. Ambikapathy, Khanna Publishing House

EC20 - Computer Networks

1. Computer Networks, M. Dave, Cengage
2. An Integrated Approach to Computer Networks, Bhavneet Sidhu, Khanna Publications
3. Telecommunication Switching System and Networks, Viswanathan, PHI
4. An Engineering Approach to Computer Networking, Keshav, Pearson

List of Recommended books for Additional Courses:

ECEL02 – Fiber Optic Communication

1. Integrated Optics, T. Tamir, Springer-Verlag,
2. Nonlinear Fiber Optics, G. Agrawal, Academic Press
3. Fiber optic Communication Systems, G. Agrawal, Wiley India

ECEL05 – Introduction to MEMS

1. Micro and Smart Systems, Ananthasuresh & Gopalkrishnan, Wiley India
2. Microsystem Design, S. D. Senturia, Kluwer Academic Publishers



ECEL07 – Antennas and Propagation

1. Micro Strip Antennas, J. Bahl and P. Bhartia, Artech House
2. Electromagnetic Waves, R.K. Shevgaonkar, Tata McGraw Hill
3. Electromagnetic Waves, R.L. Yadav, Khanna Publishing House

ECEL14 – Power Electronics

1. Modern Power Electronics, P.C. Sen, Chand & Co.
2. Power Electronics, V.R.Moorthi, Oxford University Press.
3. Power Electronics, Muhammad H. Rashid, Pearson
4. Power Electronics, Joseph Vithyaltil, TMH

List of Some Other Useful Books:

1. Microwave Circuits, K.C. Gupta, Newage Publishers
2. Fundamentals of Digital Image Processing, Anil Kumar Jain, PHI
3. Fundamentals of Digital Processing, Tamal Bose, Wiley
4. Electronic Product Design, G. Kaduskar and V.B. Baru, Wiley India
5. Information Theory, R.B. Ash, PHI
6. Telecommunication Switching Systems and Networks, T. Viswanathan, PHI
7. Elements of Electronic Navigation Systems, N.S. Nagaraja, Tata McGraw Hill
8. Control in Robotics and Automation, Ghosh, Allied Publishers
9. Robotics Technology, Deb, Wiley India
10. Switchgear & Protection, Haroon Asfaq, Khanna Book Publishing



CHEMICAL ENGINEERING UNDERGRADUATE DEGREE COURSES

SEMESTER – II (FIRST YEAR)

List of Recommended Books:

BS105 – Mathematics – II

1. Advanced Engineering Mathematics, Chandrika Prasad, Khanna Book Publishing Co. (P) Ltd., Delhi
2. Higher Engineering Mathematics, Ramana B.V., Tata McGraw
3. Advanced Engineering Mathematics (978-81-203-3609-4), Sashtry, PHI
4. Advanced Engineering Mathematics, Jain & Iyer, Narosa Publications

ESC-GES102 – Thermodynamics - I

1. An Introduction to Thermodynamics, Rao, John Wiley
2. Chemical Technology Volume – I, Pandey, Lion Press

PCC-GES103 – Electrical & Electronics Engineering

1. Basic Electrical and Electronics Engineering, Sukhija and Nagsarkar, Oxford
2. Basic Electrical and Electronics Engineering, Kothari, Nagrath, TMH
3. All-in-One Electronics Simplified, A.K. Maini, Khanna Book Publishing Co., Delhi

PCC-CS101 – Material & Energy Balance Computation

1. Basic Principles and Calculations in Chemical Engineering, Himmelblau, Phi
2. Stoichiometry, Bhatt & Vora, TMH
3. Stoichiometry and Process Calculations, Narayanan & Lakshmikutty, PHI

SEMESTER – III (SECOND YEAR)

List of Recommended Books:

ESC-GES105 – Engineering and Solid Mechanics

1. Mechanics of Materials, Punmia & Jain, Laxmi Publications
2. Strength of Materials, D.S. Bedi, Khanna Publishing House
3. Strength of Materials (Mechanics of Solid), R.S. Khurmi, S.Chand Publications

BS107 - Chemistry – II

1. Engineering Chemistry, Satyaprakash, Khanna Book Publishing, Delhi
2. A Text Book of Engg. Chemistry, Shashi Chawla, Dhanpat Rai & Co. (P) Ltd.
3. Essentials of Physical Chemistry, Bahl & Tuli, S.Chand Publishing
4. Applied Chemistry, Sunita Rattan, Kataria
5. Engineering Chemistry, Baskar, Wiley
6. Engineering Chemistry – I, D. Grouer Krishana, Vikas Publishing
7. Laboratory Manual Engg. Chemistry, Anupma Rajput, Dhanpat Rai & Co.



PC-CS103 - Thermodynamics - II

1. Chemical Engineering Thermodynamics, YVC Rao, University Press

SEMESTER – IV (SECOND YEAR)

List of Recommended Books:

PCC-CS104 – Heat Transfer

1. Process Heat Transfer and Chemical Equipment Design, D.C.Sikdar, Khanna Publishing House
2. Heat Transfer: Principles and Applications, B.K. Dutta, PHI

PCC-CS105 - Mass Transfer – I

1. Principles of Mass Transfer and Separation Processes, B.K. Dutta, PHI

PCC-CS106 - Fluid Mechanics

2. Fluid Mechanics, Sadhu Singh, Khanna Book Publishing
3. Introduction to Fluid Mechanics and Fluid Machines, Som & Biswas, TMH

ESC-GES107 - Material Science

1. Materials Science and Engineering, Raghavan, V, PHI
2. Material Science & Engineering, Upadhyaya, Anshan Publications
3. Testing of Metallic Materials, Suryanarayanan, A.V.K., Tata McGraw

PCC-CS107 - Numerical Methods in Chemical Engineering

1. Numerical Methods for Engineers, Gupta, Newage Publishers
2. Numerical Methods for Engineers with Personal Computer Applications, S.C. Chapra, McGraw

MC - Environmental Sciences

1. Textbook of Environmental Studies, Erach Bharucha, University Press
2. Environmental Studies, MP Poonia & SC Sharma, Khanna Publishing House
3. Environmental Studies, Rajagopalan, Oxford University Press

SEMESTER – V (THIRD YEAR)

List of Recommended Books:

PCC-CS108 - Chemical Reaction Engineering – I

1. Principles of Chemical Reaction Engineering, Dawande S.D, Central Techno Publications, Nagpur
2. Chemical Reaction Engineering - I, K A Gavhane, Nirali Prakashan

PCC-CS109 - Mass Transfer – II

1. Principles of Mass Transfer and Separation Processes, B.K. Dutta, PHI

PC-CS1111- Particle & Fluid Particle Processing

1. Unit Operations-I, Fluid Flow & Mechanical Operation, Gavhane, Nirali Prakashan
2. Unit Operations Vol.-I, K. A. Gavhane, Nirali Prakashan
3. Chemical Process Simulation, Husain, Wiley Eastern India



SEMESTER – VI (THIRD YEAR)

List of Recommended Books:

PCC-CS112 - Chemical Reaction Engineering – II

1. Principles of Chemical Reaction Engineering, Dawande S.D, Central Techno Publications, Nagpur
2. Chemical Reaction Engineering Vol. - II, K. A. Gavhane, Nirali Prakashan

PCC-CS113 – Process Technology & Economics

1. Dryden's Outlines of Chemical Technology, Rao, Affiliated Press
2. Chemical Process Technology, O.P. Gupta, Khanna Publishing House
3. Chemical Project Economics, Mahajani, McMillan

PCC-CS114–Process Control

1. Instrumentation and Process Control, D.C. Sikdar, Khanna Publishing House
2. Instrumentation, Measurement and Analysis, Nakra, TMH

SEMESTER – VII (FOURTH YEAR)

List of Recommended books for Additional Courses:

Water Conservation & Management

1. Elements of Water Pollution Control Engineering, OP Gupta, Khanna Publishing House, Delhi
2. Water Supply and Sanitary Engineering, Rangwala, Charotar Publications

Advanced Separation Process

1. Process Design of Equipments, Dawande, S.D., Central Techno, Nagpur

Environmental Pollution and Control

1. Elements of Environmental Pollution Control, OP Gupta, Khanna Publishing House
2. Environmental Pollution Control Engineering, C.S. Rao, Newage Publications

Renewable Energy

1. Elements of Fuels & Combustion Technology, Gupta, Khanna Publishing House
2. Energy Audit and Management, Teri Press
3. Energy Conservation, Diwan & Dwivedi, Pentagon Press
4. Non-Conventional Energy Resources, Chandra, Khanna Publishing House

Optimization Methods

1. Optimization Techniques, SS Rao, Wiley Eastern India

Petroleum Refining

1. Elements of Petroleum Refinery Engineering, Gupta, (ISBN: 9789382609728)
2. Outlines of Chemical and Petroleum Engineering, Suryanaryana & Mahto, Khanna Publishing House



UNDERGRADUATE DEGREE COURSES

SEMESTER – III (SECOND YEAR)

List of Recommended Books:

BS201 – Biology

1. Biology for Engineers (ISBN: 9781121439931), TMH

BS203 – Mathematics - III

1. Advanced Engineering Mathematics, Chandrika Prasad, Khanna Book Publishing, N.Delhi
2. Higher Engineering Mathematics, Ramana B.V., Tata McGraw Hill
3. Advanced Engineering Mathematics (ISBN:9788120336094), Sashtry, PHI

PCC-MM201 – Introduction to Materials Engineering

1. Materials Science and Engineering, Raghavan, V, PHI
2. Material Science & Engineering, Upadhyaya, Anshan Publications
3. Testing of Metallic Materials, Suryanarayanan, A.V.K., Tata McGraw

PCC-MM203 – Phase Transformation

1. Solid State Phase Transformations, V. Raghavan, PHI

ESC201 – Materials Thermodynamics

1. Metallurgical Thermodynamics, S.K. Dutta, S.Chand Publications
2. Essentials of Metallurgical Thermodynamics, R.H. Tupkary, Khanna Publishing House

ESC201 – Engineering Mechanics

1. Engineering Mechanics, D.S. Bedi, Khanna Book Publishing Co. (P) Ltd.
2. Engineering Mechanics, R.S. Khurmi, S.Chand Publishing
3. A Textbook of Engineering Mechanics, R.K. Bansal, Laxmi Publications
4. Engineering Mechanics, Sharma, Pearson
5. Applied Mechanics and Strength of Materials, Jindal, Galgotias

MC – Environmental Sciences

1. Textbook of Environmental Studies, Erach Bharucha, University Press
2. Environmental Studies, MP Poonia & SC Sharma, Khanna Publishing House
3. Environmental Studies, Rajagopalan, Oxford University Press

SEMESTER – IV (SECOND YEAR)

List of Recommended Books:

PCC-MM202 - Mechanical Properties for Materials

1. Engineering Materials, Budinski & Narasimhulu, Pearson



PCC-MM206 - Physical Metallurgy

1. Physical Metallurgy: Principles and Practice, V. Raghavan, PHI Learning

PC-MM208 - Physics of Materials

1. Physics of Materials, Essential concepts of Solid State Physics, Prathap Haridoss, Wiley India

HSMC202 - Economics for Engineers

1. Sociology & Economics for Engineers, Premvir Kapoor, Khanna Publishing House, Delhi

SEMESTER – V (THIRD YEAR)

List of Recommended Books:

PCC-MM301 - Materials Characterization

1. Materials Characterization, P.K. Maitra, PHI

PCC-MM303 - Environmental Degradation of Materials

1. Elements of Environmental Pollution Control, OP Gupta, Khanna Publishing House
2. Environmental Pollution Control Engineering, C.S. Rao, Newage Publications

SEMESTER – VII (FOURTH YEAR)

List of Recommended Books:

ESC401 - Introduction to Instrumentation

1. Instrumentation and Process Control, DC Sikdar, Khanna Publishing House

List of Recommended books for Additional Courses:

Energy Materials

Energy Technology, O.P. Gupta, Khanna Book Publishing House, Delhi

Biomaterials

Introduction to Biomaterials, Agrawal & Gopinath, Cambridge University Press

Electronic Materials

Semiconductor Materials, Devices and Fabrication, Swaminathan, Wiley India

Fatigue and Fracture Mechanics

Fatigue of Materials, Suresh, Cambridge India

Failure Analysis

Failure Analysis of Engineering Materials, Ashok Choudhury, McGraw-Hill

Powder Metallurgy

Powder Metallurgy, Upadhyaya & Upadhyaya, Universities Press

Power Metallurgy, Subramanian, PHI