Information Brochure

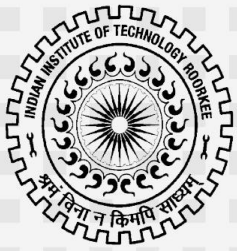
GATE2010

GRADUATE APTITUDE TEST IN ENGINEERING

- Please check that this brochure is received together with an Envelope containing Application Form and an Acknowledgement Card.
- The Application Number appearing on Application Form, Envelope and Acknowledgement Card should be IDENTICAL.
- In case of discrepancy, contact the Zonal GATE chairman.

Organising Institute

Indian Institute of Technology Guwahati



Organising Institute

Indian Institute of Technology Guwahati

CONTENTS

1. General Information

Graduate Aptitude Test in Engineering (GATE) is an all India examination administered and conducted jointly by the Indian Institute of Science and seven Indian Institutes of Technology on behalf of the National Coordination Board - GATE, Department of Higher Education, Ministry of Human Resource Development (MHRD), Government of India.

The GATE committee, which comprises of representatives from the administering institutes, is the sole authority for regulating the examination and declaring the results.

1.1. Zonal Administrative Institutes

GATE is conducted through the constitution of eight zones. The zones and the corresponding administrative institutes are:

Zone 1 - Indian Institute of Science Bangalore
Zone 2 - Indian Institute of Technology Bombay
Zone 3 - Indian Institute of Technology Delhi
Zone 4 - Indian Institute of Technology Guwahati
Zone 5 - Indian Institute of Technology Kanpur
Zone 6 - Indian Institute of Technology Kharagpur
Zone 7 - Indian Institute of Technology Madras
Zone 8 - Indian Institute of Technology Roorkee

The overall coordination and responsibility of conducting GATE 2010 lies with **Indian Institute of Technology Guwahati**, designated as the **Organising Institute for GATE 2010**.

1.2. GATE Qualification

Admission to postgraduate programmes with MHRD and some other government scholarships/assistantships in engineering colleges/institutes is open to those who qualify through GATE. GATE qualified candidates with Bachelor's degree in Engineering/Technology/Architecture or Master's degree in any branch of Science/Mathematics/Statistics/Computer Applications are eligible for admission to Master/Doctoral programmes in Engineering/Technology/Architecture as well as for Doctoral programmes in relevant branches of Science with MHRD or other government scholarships/assistantships. To avail the scholarship, the candidate must secure admission to such a postgraduate programme, as per the prevailing procedure of the admitting institution. However, candidates with Master's degree in Engineering/Technology/Architecture may seek admission to relevant PhD programmes with scholarship/assistantship without appearing in the GATE examination.

Some institutions specify GATE qualification as mandatory even for admission of self-financing students to postgraduate programmes. GATE qualified candidates are also eligible for the award of Junior Research Fellowship in CSIR Laboratories and CSIR sponsored projects. Top rank holders in some GATE papers are entitled to apply for "Shyama Prasad Mukherjee Fellowship" awarded by CSIR. Some government organizations prescribe GATE qualification as a requirement for applying to the post of a Scientist / Engineer.

1.3. Eligibility

The following categories of candidates are eligible to appear for GATE:

a) Bachelor's degree holders in Engineering/Technology/Architecture (4 years after 10+2) and those who are in the final or pre-final year of such programmes.
b) Master's degree holders in any branch of Science/Mathematics/Statistics/Computer Applications or equivalent and those who are in the final or pre-final year of such programmes.
c) Candidates in the second or higher year of the Four-year Integrated Master's degree programme (Post-B.Sc.) in Engineering/Technology or in the third or higher year of Five-year Integrated Master's degree programme and Dual Degree programme in Engineering/Technology.
d) Candidates with qualifications obtained through examinations conducted by professional societies recognized by UPSC/AICTE (e.g. AMIE by IE(I), AMICE(I) by the Institute of Civil Engineers (India)-ICE(I)) as equivalent to B.E./B.Tech. Those who have completed section A or equivalent of such professional courses are also eligible.

1.4. Examination Schedule and Cities

GATE 2010 Examination will include both ONLINE and OFFLINE examinations as per the following details:

GATE Examination	Examination mode	Examination cities	Examination Date (day)	Examination Time
GATE Examination of TF paper	Computer based ONLINE examination	Bangalore, Chennai, Delhi, Guwahati, Kanpur, Kharagpur, Mumbai, Roorkee	**February 07, 2010 (Sunday)**	**09.30 hrs – 12.30 hrs**
GATE Examination of MN paper	Computer based ONLINE examination	Bangalore, Chennai, Delhi, Guwahati, Kanpur, Kharagpur, Mumbai, Roorkee	**February 07, 2010 (Sunday)**	**14.30 hrs – 17.30 hrs**
GATE Examination in all other papers	OFFLINE	In all cities listed in Table - 2	**February 14, 2010 (Sunday)**	**09.30 hrs – 12.30 hrs**

TF : Textile Engineering and Fibre Science

MN : Mining Engineering

ONLINE Examination : Examination using computers where the candidate will select the correct answer out of four options with the help of keyboard and mouse.

OFFLINE Examination : Examination in the usual manner as in the previous years where the candidate will mark the correct answer out of four options in an Optical Response Sheet (ORS) by darkening the appropriate bubble.

Other important dates related to the examination are listed in Table-1 given below.

Table-1: Important Dates

Commencement of: sale of Information Brochure and Application Form/Online Application Form submission	Tuesday	September 22, 2009
Last date for issue of Information Brochure and Application Form: a) by post from GATE Offices b) at bank counters c) at GATE office counters	 Tuesday Wednesday Friday	 October 20, 2009 October 28, 2009 October 30, 2009
Last date for: a) Submission of Online Application Form (website closure) b) Receipt of completed Offline/Online Application Form at respective zonal GATE Office	 Wednesday Tuesday	 October 28, 2009 (18:00 hrs) November 03, 2009
Announcement of results	Monday	March 15, 2010

Computer based ONLINE examination for papers with codes MN and TF will be conducted at the Indian Institute of Science Bangalore and seven Indian Institutes of Technology (Bombay, Delhi, Guwahati, Kanpur, Kharagpur, Madras and Roorkee) only. For other papers, the examination cities are listed in Table-2. The corresponding zonal administrative institute details are also given in the same table.

1.5. Application Submission Process

a) There are two different ways by which a candidate can apply/register for GATE 2010, namely, '***Online***' and '***Offline***'. Details for applying ***Online*** and ***Offline*** are available on the websites of GATE-administrating IITs and IISc. Details for applying ***Offline*** are also given in Section 4 of this brochure.

b) The ***Offline*** application fee is Rs. 1000 for General/OBC Category candidates and Rs. 500 for SC/ST/PD* Category candidates. The ***Online*** application fee is Rs. 800 for General/OBC Category candidates and Rs. 400 for SC/ST/PD* Category candidates. The application fee is non refundable.

*Person with Disability

1.6. Other Information

a) Candidates can appear in the examination only against valid admit cards. If they do not receive the same by **January 31 , 2010**, they should contact the GATE Chairman of the zone concerned.

b) The GATE committee has the authority to decide the qualifying score for each GATE paper. In case any claim or dispute arises in respect of GATE 2010, it is hereby made absolutely clear that the Courts and Tribunals in Guwahati and Guwahati alone shall have the exclusive jurisdiction to entertain and settle any such dispute or claim.
For information, announcements and results, visit any one of the websites listed below.

IISc Bangalore	http://gate.iisc.ernet.in/
IIT Bombay	http://www.iitb.ac.in/gate
IIT Delhi	http://www.iitd.ac.in/gate
IIT Guwahati	http://www.iitg.ernet.in/gate
IIT Kanpur	http://www.iitk.ac.in/gate
IIT Kharagpur	http://gate.iitkgp.ac.in
IIT Madras	http://gate.iitm.ac.in
IIT Roorkee	http://www.iitr.ac.in/gate

Table-2: Examination cities and contact details of the zonal administrative institutes

Examination cities	Address to which completed Application Form is to be sent	Telephone, Fax and E-mail
Zone 1 Ananthapur, Bagalkot, Bangalore, Davangere, Hassan, Hyderabad, Kurnool, Mahabubnagar, Mysore and Surathkal	Chairman, GATE Indian Institute of Science Bangalore 560 012	Phone: 080-2293 2392 Fax: 080-2360 1227 E-mail: gate@gate.iisc.ernet.in
Zone 2 Ahmednagar, Akola, Amravati, Aurangabad, Gulbarga, Hubli, Jalgaon, Kolhapur, Loni, Mumbai, Nagpur, Nanded, Nasik, Navi Mumbai, Pandharpur, Pune, Sangli, Satara, Shegaon, Solapur, Thane, Wardha and Goa	Chairman, GATE Indian Institute of Technology Bombay, Powai, Mumbai 400 076	Phone: 022-2576 7068 Fax: 022-2572 3706 E-mail: gateoffice@iitb.ac.in
Zone 3 Ahmedabad, Ajmer, Alwar, Bikaner, Chandigarh, Dausa, Faridabad, Gurgaon, Jaipur, Jalandhar, Jammu, Jodhpur, Ludhiana, Mahesana, New Delhi, Patiala, Rajkot, Sikar, Surat, Udaipur and Vadodara	Chairman, GATE Indian Institute of Technology Delhi, Hauz Khas, New Delhi 110 016	Phone: 011-2659 1749 Fax: 011-2658 1579 E-mail: gate@admin.iitd.ernet.in
Zone 4 Agartala, Asansol, Bhagalpur, Dhanbad, Durgapur, Gangtok, Guwahati, Imphal, Itanagar, Jorhat, Kalyani, Patna, Silchar, Siliguri and Tezpur	Chairman, GATE Indian Institute of Technology Guwahati, Guwahati 781 039	Phone: 0361-258 2751 Fax: 0361-258 2755 E-mail: gate@iitg.ernet.in
Zone 5 Allahabad, Bhopal, Gorakhpur, Indore, Jabalpur, Jhansi, Kanpur, Lucknow, Saugar (Sagar, MP), Sultanpur, Ujjain and Varanasi	Chairman, GATE Indian Institute of Technology Kanpur, Kanpur 208 016	Phone: 0512-259 7412 Fax: 0512-259 0932 E-mail: gate@iitk.ac.in

Examination cities	Address to which completed Application Form is to be sent	Telephone, Fax and E-mail
Zone 6 Balasore, Berhampur (Orissa), Bhimavaram, Bhubaneswar, Bilaspur, Cuttack, Eluru, Jamshedpur, Kakinada (AP), Kharagpur, Kolkata, Machilipatnam, Raipur, Rajahmundry, Ranchi, Rourkela, Sambalpur, Tadepalligudem, Vijayawada and Visakhapatnam	Chairman, GATE Indian Institute of Technology Kharagpur, Kharagpur 721 302	Phone: 03222-282091 Fax: 03222-278243 E-mail: gate@adm.iitkgp.ernet.in
Zone 7 Bapatla, Chennai, Chidambaram, Chittoor, Coimbatore, Dindigul, Ernakulam, Gudur, Guntur, Kadapa (Cuddapah), Kannur, Karimnagar, Khammam, Kollam, Kothagudem, Kottayam, Kozhikode, Madurai, Manchiryal, Nagercoil, Nalgonda, Nellore, Ongole, Palakkad, Puducherry (Pondicherry), Salem, Tenali, Thanjavur, Thiruvananthapuram, Thrissur, Tiruchirapalli, Tirunelveli, Tirupati and Warangal	Chairman, GATE Indian Institute of Technology Madras, Chennai 600 036	Phone: 044-2257 8200 Fax: 044-2257 8204 E-mail: gate@iitm.ac.in
Zone 8 Agra, Aligarh, Amritsar, Bathinda, Bareilly, Bijnor, Dehradun, Ghaziabad, Gwalior, Hamirpur (HP), Haridwar, Hissar, Kota, Kurukshetra, Mathura, Meerut, Muzaffarnagar, Noida, Pantnagar, Rohtak, Roorkee, Shimla and Yamunanagar	Chairman, GATE Indian Institute of Technology Roorkee, Roorkee 247 667	Phone: 01332-284531 Fax: 01332-285707 E-mail: gate@iitr.ernet.in

2. Postgraduate admissions with MHRD scholarship

2.1. As per the directives of the Ministry of Human Resource Development (MHRD), Government of India, the following procedure is to be adopted for admission to postgraduate programmes (Master and Doctoral) with MHRD scholarship/assistantship. The GATE performance of the candidate will be considered for admission. If the candidate is to be selected through interview for post graduate programmes, minimum 70% weightage is to be given to the GATE performance. The remaining weightage (30% maximum) can be given to the candidate's academic record/performance in interview. Candidate opting for a general paper (XE or XL) may be further examined (by interview/written test) by the admitting institution. In such cases also the weightage for GATE performance should not be less than 70%. The admitting institution will prescribe minimum passing percentage of marks in the interview. Some colleges/institutes specify GATE qualification as the mandatory requirement even for admission without MHRD scholarship/assistantship.

2.2. Candidates are advised to seek details of admission procedures and availability of MHRD scholarship/assistantship from the concerned admitting institution. The criteria for post graduate admission with scholarship/assistantship are different for different admitting institutions. GATE offices will not entertain any enquiry about admission and award of scholarship/assistantship.

2.3. It is the responsibility of the admitting institution to award the MHRD scholarship/assistantship to only those candidates who secured GATE score equal to or more than the "qualifying GATE score" in the concerned GATE paper and for the corresponding candidate category. The management of the postgraduate scholarship/assistantship is also the responsibility of the admitting institution. The GATE committee also has no role in the award or disbursement of scholarship/assistantship. Similarly, reservation of seats under different categories is as per the policies and norms prevailing at the admitting institution and Government of India rules.

2.4. A candidate declared "GATE qualified at the time of admission" is entitled for MHRD fellowship for 24 months unless he/she looses it due to poor performance in the registered programme.

2.5. The students of Integrated Master Degree and Dual Degree programmes in Engineering/Technology are eligible to appear in GATE 2010 in order to qualify for the postgraduate scholarships in their own institutions only. They are not eligible for admission to a fresh M.E./M.Tech. programmes.

3. Structure of GATE 2010

3.1. Examination Type

The GATE examination consists of a single paper of 3 hours duration, which contains 65 questions carrying a maximum of 100 marks. The question paper will consist of only multiple choice objective questions. Each question will have four choices for the answer. The examination for the papers with codes TF and MN will be carried out ONLINE using computers where the candidates will be required to select the correct choice from among the four provided options. For all other papers, the candidates will have to mark the correct choice on an Optical Response Sheet (ORS) by darkening the appropriate bubble against each question. There will be negative marking for each wrong answer, as explained in Section 3.4.

3.2. What is New in GATE 2010?

3.2.1. New Paper introduced in GATE 2010

Biotechnology (BT) has been introduced as an independent paper from GATE 2010.

3.2.2. Common Component of General Aptitude (GA) introduced in GATE 2010

Each GATE paper shall have a common General Aptitude (GA) component carrying 15 marks from GATE 2010.

3.2.3. Papers to be discontinued from GATE 2010 onwards

Due to introduction of an independent paper in Biotechnology (BT), the Biotechnology section in Life Sciences (XL) paper has been discontinued from GATE 2010.

There will not be GATE 2010 examination in Pharmaceutical Sciences (PY) paper. For more information about the organization which will be conducting a GATE like examination for PY, the candidates are advised to visit GATE 2010 website from time to time.

3.3. Examination Paper

A candidate can choose any one of the papers listed in Table-3. The syllabi of all the papers are given in Annexure-I.

Table-3: List of GATE Papers and corresponding codes

PAPER	CODE	PAPER	CODE
Aerospace Engineering	AE	Instrumentation Engineering	IN
Agricultural Engineering	AG	Mathematics	MA
Architecture and Planning	AR	Mechanical Engineering	ME
Biotechnology	BT	Mining Engineering	MN$
Civil Engineering	CE	Metallurgical Engineering	MT
Chemical Engineering	CH	Physics	PH
Computer Science and Information Technology	CS	Production and Industrial Engineering	PI
Chemistry	CY	Textile Engineering and Fibre Science	TF$
Electronics and Communication Engineering	EC	Engineering Sciences	XE*
Electrical Engineering	EE	Life Sciences	XL*
Geology and Geophysics	GG#		

GG (Geology and Geophysics) paper will consist of two parts: Part A and Part B. Part A will be common for all candidates. Part B will contain two sections: Section 1 (Geology) and Section 2 (Geophysics). Candidates will have to attempt questions in Part A and either Section 1 or Section 2 in Part B.

$ GATE 2010 examination for Mining Engineering (MN) and Textile Engineering and Fibre Science (TF) papers will be computer based ONLINE examination.

***** XE (Engineering Sciences) and XL (Life sciences) papers are of general nature and will comprise of the following sections:

XE Paper SECTIONS	CODE	XL Paper SECTIONS	CODE
Engineering Mathematics (Compulsory)	***A***	***Chemistry (Compulsory)***	***H***
Fluid Mechanics	B	Biochemistry	I
Materials Science	C	Botany	J
Solid Mechanics	D	Microbiology	K
Thermodynamics	E	Zoology	L
Polymer Science and Engineering	F		
Food Technology	G		

A candidate appearing in XE or XL paper will be required to answer three sections apart from the General Aptitude (GA) questions. Section A is compulsory in XE paper and Section H is compulsory in XL paper. The candidate can choose any two out of the remaining sections listed against the respective papers.

The choice of the appropriate paper is the responsibility of the candidate. Some guidelines in this respect are suggested below:

Candidate is expected to appear in a paper (one of the listed above) appropriate to the discipline of his/her qualifying degree.

Candidate is, however, free to choose any paper according to his/her admission plan, keeping in mind the eligibility criteria of the institutions in which he/she wishes to seek admission.

3.4. Pattern of Question Papers

The pattern of examination papers is described below. This is followed by a description of multiple choice objective questions.

3.4.1. AE through TF Papers (except GG paper)

There will be a total of 65 questions carrying 100 marks. Q.1 to Q.25 (25 questions) will carry one mark each (sub-total 25 marks). Q.26 to Q.55 (30 questions) will carry two marks each (sub-total 60 marks). Questions Q.56 – Q.65 belong to General Aptitude (GA). Questions Q.56 – Q.60 will carry 1 mark each (sub-total 5 marks) and questions Q.61 – Q.65 will carry 2-marks each (sub-total 10 marks).

Questions Q.48 – Q.51 (2 pairs) are common data questions and question pairs (Q.52, Q.53) and (Q.54, Q.55) are linked answer questions. The answer to the second question of the linked answer questions depends on the answer to the first question of the pair. If the first question in the linked pair is wrongly answered or is un-attempted, then the answer to the second question in the pair will not be evaluated.

NEGATIVE MARKING: For Q.1 – Q.25 and Q.56 – Q.60, ⅓ mark will be deducted for each wrong answer. For Q.26 – Q.51 and Q.61 – Q.65, ⅔ mark will be deducted for each wrong answer. The question pairs (Q.52, Q.53), and (Q.54, Q.55) are questions with linked answers. There will be negative marks only for wrong answer to the first question of the linked answer question pair i.e. for Q.52 and Q.54, ⅔ mark will be deducted for each wrong answer. There is no negative marking for Q.53 and Q.55.

All the papers bearing the codes AE, AG, BT, CE, CH, CS, EC, EE, IN, ME, MN, MT, PI and TF will contain questions on Engineering Mathematics carrying 15 marks.

3.4.2. GG (Geology and Geophysics) Paper

There are a total of 65 questions carrying 100 marks. Apart from GA, the question paper consists of two parts: Part A and Part B. Part A is common for all candidates. Part B contains two sections: Section 1 (Geology) and Section 2 (Geophysics). Candidates will have to attempt questions in Part A and either Section 1 or Section 2 in Part B.

Part A consists of 25 questions; all questions carry 1-mark each (sub-total 25 marks). Each of the sections (Section 1 and Section 2) in Part B consists of 30 questions; all questions carry 2-marks each (sub-total 60 marks). Questions Q.48 – Q.51 (2 pairs) are common data questions and question pairs (Q.52, Q.53) and (Q.54, Q.55) are linked answer questions. The answer to the second question of the linked answer

questions pair depends on the answer to the first question of the pair. If the first question in the linked pair is wrongly answered or is un-attempted, then the answer to the second question in the pair will not be evaluated. Questions Q.56 – Q.65 belong to General Aptitude (GA). Questions Q.56 – Q.60 will carry 1-mark each (sub-total 5 marks) and questions Q.61 – Q.65 will carry 2-marks each (sub-total 10 marks).

NEGATIVE MARKING: For Q.1 – Q.25 and Q.56 – Q.60, ⅓ mark will be deducted for each wrong answer. For Q.26 – Q.51 and Q.61 – Q.65, ⅔ mark will be deducted for each wrong answer. The question pairs (Q.52, Q.53), and (Q.54, Q.55) are questions with linked answers. There will be negative marks only for wrong answer to the first question of the linked answer question pair i.e. for Q.52 and Q.54, ⅔ mark will be deducted for each wrong answer. There is no negative marking for Q.53 and Q.55.

3.4.3. XE Paper (Engineering Sciences)

There are a total of 65 questions carrying 100 marks.

There are 11 questions carrying 15 marks in XE Engineering Mathematics section paper (Section A), which is compulsory. Questions Q.1 - Q.7 will carry 1 mark each (sub-total 7 marks), and questions Q.8 - Q.11 will carry 2 marks each (sub-total 8 marks).

Each of the other XE section papers (Sections B through G) contains 22 questions carrying 35 marks. Questions Q.1 - Q.9 will carry 1-mark each (sub-total 9 marks). Questions Q.10 - Q.22 will carry 2 marks each (sub-total 26 marks) containing 2 pairs of common data and 1 pair of linked questions. Questions Q.17 - Q.20 (2 pairs) are common data questions with 2-marks each. Questions Q.21 and Q.22 (1 pair) are linked answer questions with 2-marks each. The answer to the second question of the pair of linked questions will depend on the answer to the first question of the pair. If the first question in the linked pair is wrongly answered or is un-attempted, then the answer to the second question in the pair will not be evaluated.

There are 10 questions carrying 15 marks in GA, which is compulsory. Questions Q.1 - Q.5 carry 1-mark each (sub-total 5 marks), and questions Q.6 - Q.10 carry 2-marks each (sub-total 10 marks).

NEGATIVE MARKING: In XE Section A, for Q.1 - Q.7, ⅓ mark will be deducted for each wrong answer and for Q.8 - Q.11, ⅔ mark will be deducted for each wrong answer. In all other XE section papers (Section B through G), for Q.1 - Q.9, ⅓ mark will be deducted for each wrong answer and for Q.10 - Q.20, ⅔ mark will be deducted for each wrong answer. The question pair (Q.21, Q.22) is questions with linked answers. There will be negative marks only for wrong answer to the first question of the linked answer question pair. For Q.21, ⅔mark will be deducted for wrong answer. There is no negative marking for Q.22. In GA, for Q.1 - Q.5, ⅓ mark will be deducted for each wrong answer and for Q.6 - Q.10, ⅔ mark will be deducted for each wrong answer.

3.4.4. XL Paper (Life Sciences)

There are a total of 65 questions carrying 100 marks.

There are 15 questions carrying 25 marks in XL Chemistry section paper (Section H), which is compulsory. Questions Q.1 - Q.5 will carry 1-mark each (sub-total 5 marks). Questions Q.6 - Q.15 will carry 2 marks each (sub-total 20 marks) containing 1 pair of common data and 1 pair of linked questions. Questions Q.12 and Q.13 (1 pair) are common data questions with 2 marks each. Questions Q.14 and Q.15 (1 pair) are linked answer questions with 2 marks each. The answer to the second question of the pair of linked questions will depend on the answer to the first question of the pair. If the first question in the linked pair is wrongly answered or is un-attempted, then the answer to the second question in the pair will not be evaluated.

Each of the other XL section papers (Sections I through L) contains 20 questions carrying 30 marks. Questions Q.1 - Q.10 will carry 1 mark each (sub-total 10 marks) and questions Q.11 - Q.20 will carry 2 marks each (sub-total 20 marks).

There are 10 questions carrying 15 marks in GA, which is compulsory. Questions Q.1 - Q.5 will carry 1 mark each (sub-total 5 marks), and questions Q.6 - Q.10 will carry 2 marks each (sub-total 10 marks).

NEGATIVE MARKING: In XL Section H, for Q.1 - Q.5, ⅓ mark will be deducted for each wrong answer and for Q.6 - Q.13, ⅔ mark will be deducted for each wrong answer. The question pair (Q.14, Q.15) is questions with linked answers. There will be negative marks only for wrong answer to the first question of the linked answer question pair. For Q.14, ⅔mark will be deducted for wrong answer. There is no negative marking for Q.15. In all other XL section papers (section I through L), for Q.1 - Q.10, ⅓ mark will be deducted for each wrong answer and for Q.11 - Q.20, ⅔ mark will be deducted for each wrong answer. In GA, for Q.1 - Q.5, ⅓ mark will be deducted for each wrong answer and for Q.6 - Q.10, ⅔ mark will be deducted for each wrong answer.

3.4.5. Types of multiple choice objective questions

Each of the multiple choice objective questions in all papers and sections will contain four answers, of which the correct answer is to be marked. The types of questions in a paper may be based on the following logic:

(i) Recall: These are based on facts, principles, formulae or laws of the discipline. The candidate is expected to be able to obtain the answer either from his/her memory of the subject or at most from a one-line computation.

Example
Q. During machining maximum heat is produced

(A) in flank face (B) in rake face
(C) in shear zone (D) due to friction between chip and tool

(ii) Comprehension: These questions will test the candidate's understanding of the basics of his/her field, by requiring him/her to draw simple conclusions from fundamental ideas.

Example
Q. A DC motor requires a starter in order

(A) to develop a starting torque
(B) to compensate for auxiliary field ampere turns
(C) to limit armature current at starting
(D) to provide regenerative braking

(iii) Application: In these questions, the candidate is expected to apply his/her knowledge either through computation or by logical reasoning.

Example
Q. The sequent depth ratio of a hydraulic jump in a rectangular channel is 16.48. The Froude number at the beginning of the jump is:

(A) 5.0 (B) 8.0
(C) 10.0 (D) 12.0

(iv) Analysis and Synthesis: These can be linked questions, where the answer to the first question of the pair is required in order to answer its successor. Or these can be common data questions, in which two questions share the same data but can be solved independently of one another.

Common data based questions: Multiple questions may be linked to a common data problem, passage and the like. Two or three questions can be formed from the given common data problem. Each question is independent and its solution obtainable from the above problem data/passage directly. (Answer of the previous question is not required to solve the next question). Each question under this group will carry two marks.

Example
Common Data, for instance, for Questions 48 and 49 in Main Paper:
Let X and Y be jointly distributed random variables such that the conditional distribution of Y, given X=x, is uniform on the interval (x-1,x+1). Suppose E(X)=1 and Var(X)=5/3.

First question using common data:

Q.48 The mean of the random variable Y is

(A) 1/2 (B) 1 (C) 3/2 (D) 2

Second question using common data

Q.49 The variance of the random variable Y is

(A) 1/2 (B) 2/3 (C) 1 (D) 2

Linked answer questions: These questions are of problem solving type. A problem statement is followed by two questions based on the problem statement. The two questions are designed such that the solution to the second question depends upon the answer to the first one. In other words, the first answer is an intermediate step in working out the second answer. Each question in such 'linked answer questions' will carry two marks.

Example

Statement for Linked Answer Questions, for instance, for Questions 52 and 53 in Main Paper:

The open loop transfer function of a unity feedback control system is given by

$$G(s)H(s) = \frac{K}{s(s+1)(2s+1)(3s+1)}$$

First question of the pair:

Q.52 The value of K which will cause sustained oscillations in the closed loop system is

(A) $\frac{60}{121}$ (B) $\frac{70}{121}$

(C) $\frac{80}{121}$ (D) $\frac{90}{121}$

Second question of the pair:

Q.53 The frequency of sustained oscillations is

(A) $\frac{1}{12}$ rad/sec (B) $\frac{1}{11}$ rad/sec

(C) $\frac{1}{\sqrt{12}}$ rad/sec (D) $\frac{1}{\sqrt{11}}$ rad/sec

The questions based on the above four logics may be a mix of single stand alone statement / phrase / data type questions, combination of option codes type questions or match items types questions.

3.5. GATE Results and Scorecard

3.5.1. GATE Results

a. GATE 2010 results will be announced on **March 15, 2010 at 10:00 hrs**. at GATE offices of IISc and seven IITs. GATE 2010 results will also be available on the websites, as listed in Section 1.6.

b. **GATE 2010 score is valid for TWO YEARS from the date of announcement of the GATE 2010 results.**

c. The GATE results may be made available on payment basis to interested organizations (educational institutions, R & D laboratories, industries, etc.) in India and abroad based on a Memorandum of Understanding (MOU) between IIT Guwahati and the requesting organization. Details in this regard can be obtained from the Chairman, GATE, IIT Guwahati.

d. The machine-gradable Optical Response Sheets (ORS) are graded and scrutinized with extreme care. There is no provision for regrading and retotalling. No photocopies of the machine-gradable Optical Response Sheets (ORS) will be made available. No correspondence in this regard will be entertained.

3.5.2. GATE Scorecard

Details about the contents of GATE Scorecard will be made available in the GATE websites at an appropriate time.

'There is no provision for Additional GATE scorecards'.

4. Instructions for filling and submission of Application Form

4.1. Important Information

a) Before you start filling the Application Form, please check that the Application Number printed on (i) Application Form, (ii) Acknowledgement Card and (iii) Envelope are the same. Any discrepancy should be brought to the notice of the GATE chairman of the zone from which the Application Form was purchased. The contact details of all the zonal GATE Chairmen are given in Table-2.

b) It is essential to quote the Application Number in all future correspondence with respective zonal GATE Office. The candidates are advised to keep a copy of the filled Application Form.

c) The Application Form must be folded only along the original fold line. Nothing should be stapled or pinned to it. The Barcode on the Application Form should not be tampered. The Application Form will be declared defective if these instructions are not followed.

d) Please note that ***Change of GATE Paper is not permitted*** after the submission of Application Form.
Please make sure that you have filled correct paper code in your Application Form.

e) ***Change of Examination City is permitted,*** only if a request for the same reaches the GATE Chairman of zone to which the Application Form was originally submitted, on or before **December 31 , 2009,** along with Demand Draft of Rs. 400/- as fee for change of Examination City.

NOTE: Incomplete or defective applications will be rejected outright.

4.2. Instructions for filling Application Form and Acknowledgement Card

4.2.1. General

a) The instructions given below for filling the Application Form must be followed meticulously. Refer to the Sample Application Form at the end of this section.

b) For *Items 1, 2, 8, 10, 11, 12, 14, 15a, 15b* and *16,* the candidate must write the required information in ink with black ball point pen in the boxes provided and then darken the appropriate bubble(s), using dark HB pencil only. In case of any discrepancy in the marked bubble and the corresponding boxes, the information provided through the bubble(s) will be taken as final. The text boxes are provided only for guidance.

c) For *Items 1* to *16,* the candidate must provide information by filling the appropriate bubble(s) using dark HB pencil only.

d) Darken the appropriate bubble(s) by filling it completely. For correcting any entry, completely erase the previous mark using a *soft eraser* and remove all smudges before re-filling.

e) Only BLACK BALL POINT PEN must be used for filling *Items 17* to *23.*

4.2.2. Itemwise Instructions for filling Application Form

Item 1: Name of the Candidate as in 10th Class Certificate

Fill in your name in CAPITAL LETTERS as recorded in the High School (Class 10th) certificate by your Board/ University/Institute and darken the appropriate bubbles. Your name in the GATE scorecard will appear exactly as filled in the Application Form. *Any change in the name/surname at any stage has to be duly supported by a proper affidavit.*

NOTE: In case, your name has more than 30 characters (including blanks), abbreviate it suitably to accommodate within the space provided. For example, the name RAMAKRISNA VELLURAO VENKATESH KUMAR AYYAR can be abbreviated as,

R	A	M	A	K	R	I	S	N	A		V		V	E	N	K	A	T	E	S	H		K		A	Y	Y	A	R

Item 2: Date of Birth

Fill in your date of birth as given in your High School (Class 10th) certificate in the space provided and darken the appropriate bubbles.

Example: If the date of birth is 16th September 1986, fill in as,

Date		Month		Year	
1	6	0	9	8	6

Item 3: Gender

Darken the appropriate bubble, MALE or FEMALE.

Item 4: Nationality

Darken the appropriate bubble:
INDIAN or FOREIGNER

Item 5: Category

Darken the appropriate bubble:

SC : Scheduled Caste, ST: Scheduled Tribe, OBC: Other Backward Class (non creamy layer), GN: All others

NOTE: Candidate claiming concession for buying Application Form under SC and ST categories must attach a recently obtained and duly attested copy of Caste Certificate, issued by a competent authority (see section 4.3). If the Caste Certificate is found improper, the application will be rejected.

Item 6: Person with Disability (PD)

Darken the appropriate bubble YES or NO

NOTE: PD candidate claiming concession for buying Application Form must attach an attested copy of Disability Certificate issued by appropriate medical authority. Applications with improper Disability Certificate will be rejected. If any PD candidate requires the services of an Amanuensis, he/she must attach a request for this with the Application Form.

Item 7: Choice of GATE Paper

Darken the appropriate bubble to indicate the correct choice of GATE Paper.
Refer Table-3 in Section 3.3, for the list of GATE Papers and corresponding two letter CODES.

Item 8: Choice of Examination Cities

Fill in your choice of two Examination Cities in order of preference as 1st choice and 2nd choice, and darken the appropriate bubbles.

Refer to Annexure II-A, which lists the cities where GATE 2010 will be conducted and the corresponding three digit CODES.

For candidates applying for papers with codes TF and MN, the choice of examination cities is limited to Bangalore, Chennai, Delhi, Guwahati, Kanpur, Kharagpur, Mumbai and Roorkee. According to the candidate's first choice of examination city, he/she will be allotted the corresponding zonal administrative institute as the center.

Item 9: Qualifying Degree

Darken the bubble corresponding to appropriate Degree Code. The degree code corresponds to the qualifying degree of the programme which the candidate has either completed or is presently studying in its final or pre-final year. The Degree Codes are given as below:

Degree	Code
B.E./B.Tech./ B.Sc. (Engg.)/B.Sc.(Tech.)/B.Arch.	E
Integrated M.E./M.Tech./Dual Degree	M
M.Sc./M.C.A./M.A.	S
Professional (AMIE by IE(I) , AMICE(I) by ICE(I) etc.)	P

Item 10: Year of Degree

Fill in the Year of passing / appearing in the qualifying degree examination and darken the appropriate bubbles.

Item 11: Discipline Code

Fill in the Discipline Code and darken the appropriate bubble.

Refer to Annexure II-B, which lists the two digit CODES corresponding to various disciplines of the qualifying degree/programme.

Item 12: Name of Parent

Fill in the name of your mother or father in CAPITAL LETTERS in the space provided and darken the appropriate bubbles.

Item 13: State/Union Territory of Permanent Residence

Darken the appropriate bubble corresponding to the Indian State/Union Territory of your permanent residence.

Refer to Annexure II-C, which gives the CODES for all Indian States and Union Territories.

Item 14: Mobile/Landline Phone with STD Code

Fill in mobile phone number/ landline number with the STD code including the leading 0, at which you can be contacted. Darken the appropriate bubbles.

Item 15 (a and b): College Code (Optional) and PINCODE of college address

Fill in the College Code of the college/institution, where you have studied or are studying for the qualifying degree (Refer to GATE 2010 website, which provides list of college codes). Darken the appropriate bubbles in 15a.

Similarly, fill in the PINCODE of the College/Institution where you have studied or are studying for the qualifying degree. Darken the appropriate bubbles in 15b.

NOTE: If the degree code (Item 9) is P (Professional), then Item 15 (a and b) need not be filled.

Item 16: PINCODE of Address for Correspondence

Write the PINCODE of your address of correspondence and darken the appropriate bubbles.

Item 17: E-mail Address

Write your E-mail Address (reproduce as it is) using only black ball point pen. The E-mail Address should be legible. This address will be used for all E-mail correspondences.

Item 18: Address for Correspondence

Write your postal address in CAPITAL LETTERS within the box using only *black ball point pen.* The address should be legible and should include the NAME of the candidate, and PINCODE.

NOTE: Scanned copy of this address will be used directly in all correspondence including mailing of ADMIT CARD and SCORECARD.

Item 19: Photograph

Paste your *recent* passport size clear front facial high contrast colour photograph (Size: 3 cm width x 4 cm height) in the box provided. Ensure that the application number is written at the back side of the photograph before it is pasted within the box. Please use good quality adhesive/glue, so that it does not get detached from the Application Form. *The photograph should not be stapled.* The photograph will be scanned and the scanned image will appear on the admit card as well as the scorecard. *The photograph should NOT be attested or signed by anyone.*

Item 20: Full Signature of the Candidate

Sign in full within the box provided, using only black ball point pen. The form must be signed only by the candidate and not by any other person. Signature in the form of initials is not permitted. This signature will be scanned and put on the Admit Card as well as the Scorecard.

NOTE: If the candidate's signature on the Optical Response Sheet (ORS), at the time of the examination, does not match with the signature on the Admit Card, the candidate will be disqualified.

Item 21: Declaration by the Candidate

Read and sign the declaration using only black ball point pen, and write the Place and Date. *The signature must be identical to that in Item 20 .*

Item 22: Check List

Fill up items in the Check List by ticking ✓ in the appropriate boxes.

Item 23: List of Attachments

Tick YES for the attachments enclosed with the Application Form, otherwise, tick NO.

4.2.3. Filling of Acknowledgement Card

Fill in the Acknowledgement Card with all the required details and enclose it with the Application Form.

4.3. Authorities empowered to issue Certificates

4.3.1 SC/ST Category

a) District Magistrate/ Additional District Magistrate/ Collector/ Deputy Collector/ Deputy Commissioner/ Additional Deputy Commissioner/ 1st Class Stipendiary Magistrate/ City Magistrate/ Sub-Divisional Magistrate/ Taluk Magistrate/ Executive Magistrate/ Extra Assistant Commissioner

b) Chief Presidency Magistrate/ Additional Chief Presidency Magistrate/ Presidency Magistrate

c) Revenue Officer not below the rank of Tashildar

d) Sub-Divisional Officer of the area where the Candidate and/or her/his family normally resides

e) Administrator/ Secretary to Administrator/ Development Officer (Lakshadweep Islands)

Certificate issued by any other official will not be accepted.

4.3.2. PD Category

In order to avail concession under PD category, the candidates should ensure themselves that they have attached recently obtained proper PD certificate, which shall be required to be submitted to the admitting institution at the time of admission. The onus of verifying PD certificate lies with the admitting institute. The GATE committee will not be responsible for any incorrect declaration of his/her PD status.

4.3.3. OBC (non creamy layer)

In order to avail concession under OBC (non creamy layer) category, the candidates should ensure themselves that they have obtained proper OBC (non creamy layer) certificate, which shall be required to be submitted to the admitting institution at the time of admission. The onus of verifying OBC (non creamy layer) certificate lies with the admitting institute. The GATE committee will not be responsible for any incorrect declaration of his/her category.

4.4. Filling and Submission of Application Envelope

On the application envelope, fill in the CODE of the examination city corresponding to your first choice (Item No. 9 of Application Form) and your chosen GATE Paper Code (Item No. 8 of Application Form).

Write your postal address in the designated space. The envelope should be addressed to the Chairman, GATE, of the Zone corresponding to the 1st Choice of Examination City of the candidate. See Table-2 for addresses of zonal GATE offices.

Completed Application Form must reach the Chairman, GATE of the Zone, where the candidate prefers (corresponding to the 1st Choice of Examination City) to appear for the examination, on or before Tuesday, November 03, 2009, by Registered/Speed Post only. It may also be submitted in person at the GATE office counter of the concerned zone.

APPLICATION FORM - GATE 2010

Before filling up this form, read instructions in the Information Brochure

SIDE-1

- USE HB PENCIL ONLY TO DARKEN THE BUBBLES.
- DARKEN THE BUBBLES FULLY.
- DO NOT MAKE ANY STRAY MARKS ON THIS SHEET.
- ERASE COMPLETELY BEFORE MAKING CORRECTIONS.

APPLICATION FORM INCOMPLETE IN ANY RESPECT WILL BE REJECTED.

USE HB PENCIL ONLY

1. Name of the Candidate as in 10th Class Certificate (in capital letters): GOPAL BORA

2. Date of Birth: Date 24, Month 09, Year 84

3. Gender: MALE ●, FEMALE ○

4. Nationality: INDIAN ●, FOREIGNER ○

5. Category: SC ○, ST ○, OBC (non creamy layer) ○, GN ●

6. Person with Disability: YES ○, NO ○

7. Choice of GATE Paper: AE ○, AG ○, AR ○, BT ○, CE ○, CH ○, CS ○, CY ●, EC ○, EE ○, GG ○, IN ○, MA ○, ME ○, MN ○, MT ○, PH ○, PI ○, TF ○, XE ○, XL ○

8. Choice of Examination Cities: 1st Choice 410, 2nd Choice 407

9. Qualifying Degree: E ○, M ○, S ●, P ○

10. Year of Degree: 2008

11. Discipline Code: 67

APPLICATION NO. 408525

17. E-mail Address: gopb@gmail.com

18. Address for Correspondence (Write with BLACK BALL POINT PEN in Capital Letters)

NAME: GOPAL BORA

ADDRESS: C/O. K. BORA

HOUSE NO. A/260

PANBAZAR, GUWAHATI

ASSAM PIN CODE: 781001

19. Photograph

APPLICATION NO. 408525

20. Signature of the Candidate (WITH BLACK BALL POINT PEN ONLY): Gopal Bora

PLEASE TURN OVER

SIDE-2

12. Name of Parent (in capital letters)

KAMAL BORA

15a. College Code (Optional)

AS 010

15b. PIN CODE of College Address

786004

13. State/Union Territory of Permanent Residence

AN	DL	LD	PY
AP	GA	MA	RJ
AR	GJ	MH	SM
AS	HP	MN	TA
BR	DR	MP	TN
CG	JD	MZ	UK
CH	JK	NL	UP
DD	KA	OR	WB
DH	KL	PB	OT

14. Mobile/Landline Phone with STD Code

09876543211

16. PIN CODE of Address for Correspondence

781001

21. DECLARATION BY THE CANDIDATE

I hereby declare that all the particulars stated in this application are true to the best of my knowledge and belief. I have read the Information Brochure and I shall abide by the terms and conditions therein. In the event of suppression or distortion of any fact in my application form, I understand that I will be denied the opportunity to appear in GATE 2010. Further, if any such suppression or distortion of facts is found after appearing in the examination, any admission/degree acquired on the basis of GATE 2010 score is liable to be cancelled.

Place: Guwahati
Date: 05/10/2009

Gopal Bora
Signature of the Candidate

22. CHECK LIST

	YES	NO
a. Filled-in all the items 1-16 completely?	☑	☐
b. Written (with black ball point pen) the E-mail Address under Item 17?	☑	☐
c. Written (with black ball point pen) the address for correspondence under Item 18?	☑	☐
d. Pasted a recent photograph in the box under Item 19?	☑	☐
e. Signed (with black ball point pen) in the box under item 20?	☑	☐
f. Signed (with black ball point pen) the declaration under Item 21?	☑	☐
g. Filled-in the Code of the first choice of examination city on application envelope?	☑	☐
h. Filled-in the chosen GATE Paper Code on the application envelope?	☑	☐
i. Kept a photocopy of the filled application form for your own records?	☑	☐

23. LIST OF ATTACHMENTS

	YES	NO	N/A
a. Original Bank Pay-in Slip / Receipt from GATE Office	☑	☐	
b. Attested copy of SC/ST Certificate (if applicable)	☐	☐	☑
c. Attested copy of PD Certificate (if applicable)	☐	☐	☑
d. In case of PD candidate, requested for Amanuensis (if applicable)	☐	☐	☑
e. Attested copy of the affidavit for Change of Name/Surname (if applicable)	☐	☐	☑
f. Duly completed and stamped Acknowledgement Card	☑	☐	

ANNEXURE –I : Syllabi for GATE Papers

General Aptitude (GA) component common in all papers –

Verbal Ability: English grammar, sentence completion, verbal analogies, word groups, instructions, critical reasoning and verbal deduction.

Numerical Ability: Numerical computation, numerical estimation, numerical reasoning and data interpretation.

1. Aerospace Engineering –AE

ENGINEERING MATHEMATICS

Linear Algebra: Matrix algebra, systems of linear equations, eigen values and eigen vectors.

Calculus: Functions of single variable, limit, continuity and differentiability, mean value theorems, evaluation of definite and improper integrals, partial derivatives, total derivative, maxima and minima, gradient, divergence and curl, vector identities, directional derivatives, line, surface and volume integrals. Theorems of Stokes, Gauss and Green.

Differential Calculus: First order linear and nonlinear equations, higher order linear ODEs with constant coefficients, Cauchy and Euler equations, initial and boundary value problems, Laplace transforms. Partial differential equations and separation of variables methods.

Numerical methods: Numerical solution of linear and nonlinear algebraic equations, integration by trapezoidal and Simpson rule, single and multi-step methods for differential equations.

FLIGHT MECHANICS

Atmosphere: Properties, standard atmosphere. Classification of aircraft. Airplane (fixed wing aircraft) configuration and various parts.

Airplane performance: Pressure altitude; equivalent, calibrated, indicated air speeds; Primary flight instruments: Altimeter, ASI, VSI, Turn-bank indicator. Drag polar; take off and landing; steady climb & descent,-absolute and service ceiling; cruise, cruise climb, endurance or loiter; load factor, turning flight, V-n diagram; Winds: head, tail & cross winds.

Static stability: Angle of attack, sideslip; roll, pitch & yaw controls; longitudinal stick fixed & free stability, horizontal tail position and size; directional stability, vertical tail position and size; dihedral stability. Wing dihedral, sweep & position; hinge moments, stick forces.

Dynamic stability: Euler angles; Equations of motion; aerodynamic forces and moments, stability & control derivatives; decoupling of longitudinal and lat-directional dynamics; longitudinal modes; lateral-directional modes.

SPACE DYNAMICS

Central force motion, determination of trajectory and orbital period in simple cases. Orbit transfer, in-plane and out-of-plane. Elements of rocket motor performance.

AERODYNAMICS

Basic Fluid Mechanics: Incompressible irrotational flow, Helmholtz and Kelvin theorem, singularities and superposition, viscous flows, boundary layer on a flat plate.

Airfoils and wings: Classification of airfoils, aerodynamic characteristics, high lift devices, Kutta Joukowski theorem; lift generation; thin airfoil theory; wing theory; induced drag; qualitative treatment of low aspect ratio wings.

Viscous Flows: Flow separation, introduction to turbulence, transition, structure of a turbulent boundary layer.

Compressible Flows: Dynamics and Thermodynamics of I-D flow, isentropic flow, normal shock, oblique shock, Prandtl-Meyer flow, flow in nozzles and diffusers, inviscid flow in a c-d nozzle, flow in diffusers. subsonic and supersonic airfoils, compressibility effects on lift and drag, critical and drag divergence Mach number, wave drag.

Wind Tunnel Testing: Measurement and visualisation techniques.

STRUCTURES

Stress and Strain: Equations of equilibrium, constitutive law, strain-displacement relationship, compatibility equations, plane stress and strain, Airy's stress function.

Flight Vehicle Structures: Characteristics of aircraft structures and materials, torsion, bending and flexural shear. Flexural shear flow in thin-walled sections. Buckling. Failure theories. Loads on aircraft.

Structural Dynamics: Free and forced vibration of discrete systems. Damping and resonance. Dynamics of continuous systems.

PROPULSION

Thermodynamics of Aircraft Gas Turbine engines, thrust and thrust augmentation.

Turbomachinery: Axial compressors and turbines, centrifugal pumps and compressors.

Aerothermodynamics of non rotating propulsion components: Intakes, combustor and nozzle. Thermodynamics of ramjets and scramjets. Elements of rocket propulsion.

2. Agricultural Engineering – AG

ENGINEERING MATHEMATICS

Linear Algebra: Matrices and Determinants, Systems of linear equations, Eigen values and eigen vectors.

Calculus: Limit, continuity and differentiability; Partial Derivatives; Maxima and minima; Sequences and series; Test for convergence; Fourier series.

Vector Calculus: Gradient; Divergence and Curl; Line; surface and volume integrals; Stokes, Gauss and Green's theorems.

Differential Equations: Linear and non-linear first order ODEs; Higher order linear ODEs with constant coefficients; Cauchy's and Euler's equations; Laplace transforms; PDEs - Laplace, heat and wave equations.

Probability and Statistics: Mean, median, mode and standard deviation; Random variables; Poisson, normal and binomial distributions; Correlation and regression analysis.

Numerical Methods: Solutions of linear and non-linear algebraic equations; integration of trapezoidal and Simpson's rule; single and multi-step methods for differential equations.

FARM MACHINERY AND POWER

Sources of power on the farm-human, animal, mechanical, electrical, wind, solar and biomass; bio-fuels; design and selection of machine elements - gears, pulleys, chains and sprockets and belts; overload safety devices used in farm machinery; measurement of force, torque, speed, displacement and acceleration on machine elements.

Soil tillage; forces acting on a tillage tool; hitch systems and hitching of tillage implements; mechanics of animal traction; functional requirements, principles of working, construction and operation of manual, animal and power operated equipment for tillage, sowing, planting, fertilizer application, inter-cultivation, spraying, mowing, chaff cutting, harvesting, threshing and transport; testing of agricultural machinery and equipment; calculation of performance parameters -field capacity, efficiency, application rate and losses; cost analysis of implements and tractors

Thermodynamic principles of I.C. engines; I.C. engine cycles; engine components; fuels and combustion; lubricants and their properties; I.C. engine systems - fuel, cooling, lubrication, ignition, electrical, intake and exhaust; selection, operation, maintenance and repair of I.C. engines; power efficiencies and measurement; calculation of power, torque, fuel consumption, heat load and power losses.

Tractors and power tillers - type, selection, maintenance and repair; tractor clutches and brakes; power transmission systems - gear trains, differential, final drives and power take-off; mechanics of tractor chassis; traction theory; three point hitches-free link and restrained link operations; mechanical steering and hydraulic control systems used in tractors; human engineering and safety in tractor design; tractor tests and performance.

SOIL AND WATER CONSERVATION ENGINEERING

Ideal and real fluids, properties of fluids; hydrostatic pressure and its measurement; hydrostatic forces on plane and curved surface; continuity equation; Bernoulli's theorem; laminar and turbulent flow in pipes, Darcy- Weisbach and Hazen-Williams equations, Moody's diagram; flow through orifices and notches; flow in open channels.

Engineering properties of soils; fundamental definitions and relationships; index properties of soils; permeability and seepage analysis; shear strength, Mohr's circle of stress, active and passive earth pressures; stability of slopes.

Hydrological cycle; meteorological parameters and their measurement, analysis of precipitation data; abstraction from precipitation; runoff; hydrograph analysis, unit hydrograph theory and application; stream flow measurement; flood routing, hydrological reservoir and channel routing.

Measurement of distance and area; chain surveying, methods of traversing; measurement of angles and bearings, plane table surveying; types of levelling; contouring; instruments for surveying and levelling; computation of earth work.

Mechanics of soil erosion, soil erosion types; wind and water erosion; factors affecting erosion; soil loss estimation; biological and engineering measures to control erosion; terraces and bunds; vegetative waterways; gully control structures, drop, drop inlet and chute spillways; earthen dams; water harvesting structures, farm ponds, watershed management.

Soil-water-plant relationship, water requirement of crops; consumptive use and evapotranspiration; irrigation scheduling; irrigation efficiencies; design of irrigation channels; measurement of soil moisture, irrigation water and infiltration; surface, sprinkler and drip methods of irrigation; design and evaluation of irrigation methods.

Drainage coefficient; planning, design and layout of surface and sub-surface drainage systems; leaching requirement and salinity control; irrigation and drainage water quality.

Groundwater occurrence confined and unconfined aquifers, evaluation of aquifer properties; well hydraulics; groundwater recharge.

Classification of pumps; pump characteristics; pump selection and installation.

AGRICULTURAL PROCESSING AND FOOD ENGINEERING

Steady state heat transfer in conduction, convection and radiation; transient heat transfer in simple geometry; condensation and boiling heat transfer; working principles of heat exchangers; diffusive and convective mass transfer; simultaneous heat and mass transfer in agricultural processing operations.

Material and energy balances in food processing systems; water activity, sorption and desorption isotherms; centrifugal separation of solids, liquids and gases; kinetics of microbial death - pasteurization and sterilization of liquid foods;

preservation of food by cooling and freezing; refrigeration and cold storage basics and applications; psychrometry - properties of air-vapour mixture; concentration and drying of liquid foods - evaporators, tray, drum and spray dryers.
Mechanics and energy requirement in size reduction of granular solids; particle size analysis for comminuted solids; size separation by screening; fluidization of granular solids-pneumatic, bucket, screw and belt conveying; cleaning and grading; Effectiveness of grain cleaners.

Hydrothermal treatment, drying and milling of cereals, pulses and oilseeds; Processing of seeds, spices, fruits and vegetables; By-product utilization from processing industries.

Controlled and modified atmosphere storage; Perishable food storage, godowns, bins and grain silos.

3. Architecture and Planning – AR

City planning: Evolution of cities; principles of city planning; types of cities & new towns; planning regulations and building byelaws; eco-city concept; sustainable development.

Housing: Concept of housing; neighbourhood concept; site planning principles; housing typology; housing standards; housing infrastructure; housing policies, finance and management; housing programs in India; self help housing.

Landscape Design: Principles of landscape design and site planning; history of landscape styles; landscape elements and materials; plant characteristics & planting design; environmental considerations in landscape planning.

Computer Aided Design: Application of computers in architecture and planning; understanding elements of hardware and software; computer graphics; programming languages – C and Visual Basic and usage of packages such as AutoCAD, 3D-Studio, 3D Max.

Environmental Studies in Building Science: Components of Ecosystem; ecological principles concerning environment; climate responsive design; energy efficient building design; thermal comfort; solar architecture; principles of lighting and styles for illumination; basic principles of architectural acoustics; environment pollution, their control & abatement.

Visual and Urban Design: Principles of visual composition; proportion, scale, rhythm, symmetry, harmony, datum, balance, form, colour, texture; sense of place and space, division of space; barrier free design; focal point, vista, image ability, visual survey, figure-background relationship.

History of Architecture: *Indian* – Indus valley, Vedic, Buddhist, Indo-Aryan, Dravidian and Mughal periods; *European* – Egyptian, Greek, Roman, medieval and renaissance periods- construction and architectural styles; vernacular and traditional architecture.

Development of Contemporary Architecture: Architectural developments and impacts on society since industrial revolution; influence of modern art on architecture; works of national and international architects; art novuea, eclecticism, international styles, post modernism, deconstruction in architecture.

Building Services: Water supply, sewerage and drainage systems; sanitary fittings and fixtures; plumbing systems, principles of internal & external drainage systems, principles of electrification of buildings, intelligent buildings; elevators & escalators, their standards and uses; air-conditioning systems; fire fighting systems, building safety and security systems.

Building Construction and Management: Building construction techniques, methods and details; building systems and prefabrication of building elements; principles of modular coordination; estimation, specification, valuation, professional practice; project management techniques e.g., PERT, CPM etc;

Materials and Structural Systems: Behavioural characteristics of all types of building materials e.g. mud, timber, bamboo, brick, concrete, steel, glass, FRP, different polymers, composites; principles of strength of materials; design of structural elements in wood, steel and RCC; elastic and limit state design; complex structural systems; principles of pre-stressing; tall buildings; principles of disaster resistant structures.

Planning Theory: Regional planning; settlement system planning; history of human settlements; growth of cities & metropolises; principles of Ekistics; rural-urban migration; urban conservation; urban renewal; Five-year plan; structural and sectoral plan.

Techniques of Planning: Planning survey techniques; preparation of urban and regional structure plans, development plans, action plans; site planning principles and design; statistical methods of data analysis; application of G.I.S and remote sensing techniques in urban and regional planning; decision making models.

Traffic and Transportation Planning: Principles of traffic engineering and transportation planning; traffic survey methods; design of roads, intersections, grade separators and parking areas; hierarchy of roads and levels of services; traffic and transport management in urban areas, intelligent transportation system; mass transportation planning; para-transits and other modes of transportation, pedestrian & slow moving traffic planning.

Infrastructure, Services and Amenities: Principles of water supply and sanitation systems; water treatment; solid waste disposal systems; waste treatment, recycle & reuse; urban rainwater harvesting; power supply and communication systems -- - network, design & guidelines; demography related standards at various levels of the settlements for health, education, recreation, religious & public-semi public facilities.

Development Administration and Management: Planning laws; development control and zoning regulations; laws relating to land acquisition; development enforcements, urban land ceiling; land management techniques; planning and municipal administration; disaster mitigation management; 73rd & 74th Constitutional amendments; valuation & taxation; revenue resources and fiscal management; public participation and role of NGO & CBO; Institutional networking & capacity building.

4. Biotechnology-BT

Linear Algebra: Matrices and determinants, Systems of linear equations, Eigen values and Eigen vectors.

Calculus: Limit, continuity and differentiability, Partial derivatives, Maxima and minima, Sequences and series, Test for convergence, Fourier Series.

Differential Equations: Linear and nonlinear first order ODEs, higher order ODEs with constant coefficients, Cauchy's and Euler's equations, Laplace transforms, PDE- Laplace, heat and wave equations.

Probability and Statistics: Mean, median, mode and standard deviation, Random variables, Poisson, normal and binomial distributions, Correlation and regression analysis.

Numerical Methods: Solution of linear and nonlinear algebraic equations, Integration of trapezoidal and Simpson's rule, Single and multistep methods for differential equations.

Microbiology: Prokaryotic and eukaryotic cell structure; Microbial nutrition, growth and control; Microbial metabolism (aerobic and anaerobic respiration, photosynthesis); Nitrogen fixation; Chemical basis of mutations and mutagens; Microbial genetics (plasmids, transformation, transduction, conjugation); Microbial diversity and characteristic features; Viruses.

Biochemistry: Biomolecules and their conformation; Ramachandran map; Weak inter-molecular interactions in biomacromolecules; Chemical and functional nature of enzymes; Kinetics of single substrate and bi-substrate enzyme catalyzed reactions; Bioenergetics; Metabolism (Glycolysis, TCA and Oxidative phosphorylation); Membrane transport and pumps; Cell cycle and cell growth control; Cell signaling and signal transduction; Biochemical and biophysical techniques for macromolecular analysis.

Molecular Biology and Genetics: Molecular structure of genes and chromosomes; DNA replication and control; Transcription and its control; Translational processes; Regulatory controls in prokaryotes and eukaryotes; Mendelian inheritance; Gene interaction; Complementation; Linkage, recombination and chromosome mapping; Extrachromosomal inheritance; Chromosomal variation; Population genetics; Transposable elements, Molecular basis of genetic diseases and applications.

Process Biotechnology: Bioprocess technology for the production of cell biomass and primary/secondary metabolites, such as baker's yeast, ethanol, citric acid, amino acids, exo-polysacharides, antibiotics and pigments etc.; Microbial production, purification and bioprocess application(s) of industrial enzymes; Production and purification of recombinant proteins on a large scale; Chromatographic and membrane based bioseparation methods; Immobilization of enzymes and cells and their application for bioconversion processes.

Aerobic and anaerobic biological processes for stabilization of solid / liquid wastes; Bioremediation.

Bioprocess Engineering: Kinetics of microbial growth, substrate utilization and product formation; Simple structured models; Sterilization of air and media; Batch, fed-batch and continuous processes; Aeration and agitation; Mass transfer in bioreactors; Rheology of fermentation fluids; Scale-up concepts; Design of fermentation media; Various types of microbial and enzyme reactors; Instrumentation in bioreactors.

Plant and Animal Biotechnology: Special features and organization of plant cells; Totipotency; Regeneration of plants; Plant products of industrial importance; Biochemistry of major metabolic pathways and products; Autotrophic and heterotrophic growth; Plant growth regulators and elicitors; Cell suspension culture development: methodology, kinetics of growth and production formation, nutrient optimization; Production of secondary metabolites by plant suspension cultures; Hairy root cultures and their cultivation. Techniques in raising transgencies.

Characteristics of animal cells: Metabolism, regulation and nutritional requirements for mass cultivation of animal cell cultures; Kinetics of cell growth and product formation and effect of shear force; Product and substrate transport; Micro & macro-carrier culture; Hybridoma technology; Live stock improvement; Cloning in animals; Genetic engineering in animal cell culture; Animal cell preservation.

Immunology: The origin of immunology; Inherent immunity; Humoral and cell mediated immunity; Primary and secondary lymphoid organ; Antigen; B and T cells and Macrophages; Major histocompatibility complex (MHC); Antigen processing and presentation; Synthesis of antibody and secretion; Molecular basis of antibody diversity; Polyclonal and monoclonal antibody; Complement; Antigen-antibody reaction; Regulation of immune response; Immune tolerance; Hyper sensitivity; Autoimmunity; Graft versus host reaction.

Recombinant DNA Technology: Restriction and modification enzymes; Vectors: plasmid, bacteriophage and other viral vectors, cosmids, Ti plasmid, yeast artificial chromosome; cDNA and genomic DNA library; Gene isolation; Gene cloning; Expression of cloned gene; Transposons and gene targeting; DNA labeling; DNA sequencing; Polymerase chain reactions; DNA fingerprinting; Southern and northern blotting; In-situ hybridization; RAPD; RFLP; Site-directed mutagenesis; Gene transfer technologies; Gene therapy.

Bioinformatics: Major bioinformatics resources (NCBI, EBI, ExPASy); Sequence and structure databases; Sequence analysis (biomolecular sequence file formats, scoring matrices, sequence alignment, phylogeny); Genomics and Proteomics (Large scale genome sequencing strategies; Comparative genomics; Understanding DNA microarrays and protein arrays); Molecular modeling and simulations (basic concepts including concept of force fields).

5. Civil Engineering – CE

ENGINEERING MATHEMATICS

Linear Algebra: Matrix algebra, Systems of linear equations, Eigen values and eigenvectors.

Calculus: Functions of single variable, Limit, continuity and differentiability, Mean value theorems, Evaluation of definite and improper integrals, Partial derivatives, Total derivative, Maxima and minima, Gradient, Divergence and Curl, Vector identities, Directional derivatives, Line, Surface and Volume integrals, Stokes, Gauss and Green's theorems.

Differential equations: First order equations (linear and nonlinear), Higher order linear differential equations with constant coefficients, Cauchy's and Euler's equations, Initial and boundary value problems, Laplace transforms, Solutions of one dimensional heat and wave equations and Laplace equation.

Complex variables: Analytic functions, Cauchy's integral theorem, Taylor and Laurent series.

Probability and Statistics: Definitions of probability and sampling theorems, Conditional probability, Mean, median, mode and standard deviation, Random variables, Poisson, Normal and Binomial distributions.

Numerical Methods: Numerical solutions of linear and non-linear algebraic equations Integration by trapezoidal and Simpson's rule, single and multi-step methods for differential equations.

STRUCTURAL ENGINEERING

Mechanics: Bending moment and shear force in statically determinate beams. Simple stress and strain relationship: Stress and strain in two dimensions, principal stresses, stress transformation, Mohr's circle. Simple bending theory, flexural and shear stresses, unsymmetrical bending, shear centre. Thin walled pressure vessels, uniform torsion, buckling of column, combined and direct bending stresses.

Structural Analysis: Analysis of statically determinate trusses, arches, beams, cables and frames, displacements in statically determinate structures and analysis of statically indeterminate structures by force/ energy methods, analysis by displacement methods (slope deflection and moment distribution methods), influence lines for determinate and indeterminate structures. Basic concepts of matrix methods of structural analysis.

Concrete Structures: Concrete Technology- properties of concrete, basics of mix design. Concrete design- basic working stress and limit state design concepts, analysis of ultimate load capacity and design of members subjected to flexure, shear, compression and torsion by limit state methods. Basic elements of prestressed concrete, analysis of beam sections at transfer and service loads.

Steel Structures: Analysis and design of tension and compression members, beams and beam- columns, column bases. Connections- simple and eccentric, beam–column connections, plate girders and trusses. Plastic analysis of beams and frames.

GEOTECHNICAL ENGINEERING

Soil Mechanics: Origin of soils, soil classification, three-phase system, fundamental definitions, relationship and interrelationships, permeability & seepage, effective stress principle, consolidation, compaction, shear strength.

Foundation Engineering: Sub-surface investigations- scope, drilling bore holes, sampling, penetration tests, plate load test. Earth pressure theories, effect of water table, layered soils. Stability of slopes-infinite slopes, finite slopes. Foundation types-foundation design requirements. Shallow foundations-bearing capacity, effect of shape, water table and other factors, stress distribution, settlement analysis in sands & clays. Deep foundations–pile types, dynamic & static formulae, load capacity of piles in sands & clays, negative skin friction.

WATER RESOURCES ENGINEERING

Fluid Mechanics and Hydraulics: Properties of fluids, principle of conservation of mass, momentum, energy and corresponding equations, potential flow, applications of momentum and Bernoulli's equation, laminar and turbulent flow, flow in pipes, pipe networks. Concept of boundary layer and its growth. Uniform flow, critical flow and gradually varied flow in channels, specific energy concept, hydraulic jump. Forces on immersed bodies, flow measurements in channels, tanks and pipes. Dimensional analysis and hydraulic modeling. Kinematics of flow, velocity triangles and specific speed of pumps and turbines.

Hydrology: Hydrologic cycle, rainfall, evaporation, infiltration, stage discharge relationships, unit hydrographs, flood estimation, reservoir capacity, reservoir and channel routing. Well hydraulics.

Irrigation: Duty, delta, estimation of evapo-transpiration. Crop water requirements. Design of: lined and unlined canals, waterways, head works, gravity dams and spillways. Design of weirs on permeable foundation. Types of irrigation system, irrigation methods. Water logging and drainage, sodic soils.

ENVIRONMENTAL ENGINEERING

Water requirements: Quality standards, basic unit processes and operations for water treatment. Drinking water standards, water requirements, basic unit operations and unit processes for surface water treatment, distribution of water. Sewage and sewerage treatment, quantity and characteristics of wastewater. Primary, secondary and tertiary treatment of wastewater, sludge disposal, effluent discharge standards. Domestic wastewater treatment, quantity of characteristics of domestic wastewater, primary and secondary treatment Unit operations and unit processes of domestic wastewater, sludge disposal.

Air Pollution: Types of pollutants, their sources and impacts, air pollution meteorology, air pollution control, air quality standards and limits.

Municipal Solid Wastes: Characteristics, generation, collection and transportation of solid wastes, engineered systems for solid waste management (reuse/ recycle, energy recovery, treatment and disposal).
Noise Pollution: Impacts of noise, permissible limits of noise pollution, measurement of noise and control of noise pollution.

TRANSPORTATION ENGINEERING

Highway Planning: Geometric design of highways, testing and specifications of paving materials, design of flexible and rigid pavements.

Traffic Engineering: Traffic characteristics, theory of traffic flow, intersection design, traffic signs and signal design, highway capacity.

SURVEYING

Importance of surveying, principles and classifications, mapping concepts, coordinate system, map projections, measurements of distance and directions, leveling, theodolite traversing, plane table surveying, errors and adjustments, curves.

6. Chemical Engineering – CH

ENGINEERING MATHEMATICS

Linear Algebra*:* Matrix algebra, Systems of linear equations, Eigen values and eigenvectors.

Calculus*:* Functions of single variable, Limit, continuity and differentiability, Mean value theorems, Evaluation of definite and improper integrals, Partial derivatives, Total derivative, Maxima and minima, Gradient, Divergence and Curl, Vector dentities, Directional derivatives, Line, Surface and Volume integrals, Stokes, Gauss and Green's theorems.

Differential equations*:* First order equations (linear and nonlinear), Higher order linear differential equations with constant coefficients, Cauchy's and Euler's equations, Initial and boundary value problems, Laplace transforms, Solutions of one dimensional heat and wave equations and Laplace equation.

Complex variables*:*Analytic functions, Cauchy's integral theorem, Taylor and Laurent series, Residue theorem.

Probability and Statistics*:* Definitions of probability and sampling theorems, Conditional probability, Mean, median, mode and standard deviation, Random variables, Poisson, Normal and Binomial distributions.

Numerical Methods*:* Numerical solutions of linear and non-linear algebraic equations Integration by trapezoidal and Simpson's rule, single and multi-step methods for differential equations.

CHEMICAL ENGINEERING

Process Calculations and Thermodynamics: Laws of conservation of mass and energy; use of tie components; recycle, bypass and purge calculations; degree of freedom analysis. First and Second laws of thermodynamics. First law application to close and open systems. Second law and Entropy Thermodynamic properties of pure substances: equation of state and departure function, properties of mixtures: partial molar properties, fugacity, excess properties and activity coefficients; phase equilibria: predicting VLE of systems; chemical reaction equilibria.

Fluid Mechanics and Mechanical Operations: Fluid statics, Newtonian and non-Newtonian fluids, Bernoulli equation, Macroscopic friction factors, energy balance, dimensional analysis, shell balances, flow through pipeline systems, flow meters, pumps and compressors, packed and fluidized beds, elementary boundary layer theory, size reduction and size separation; free and hindered settling; centrifuge and cyclones; thickening and classification, filtration, mixing and agitation; conveying of solids.

Heat Transfer: Conduction, convection and radiation, heat transfer coefficients, steady and unsteady heat conduction, boiling, condensation and evaporation; types of heat exchangers and evaporators and their design.

Mass Transfer: Fick's laws, molecular diffusion in fluids, mass transfer coefficients, film, penetration and surface renewal theories; momentum, heat and mass transfer analogies; stagewise and continuous contacting and stage efficiencies; HTU & NTU concepts design and operation of equipment for distillation, absorption, leaching, liquid-liquid extraction, drying, humidification, dehumidification and adsorption.

Chemical Reaction Engineering: Theories of reaction rates; kinetics of homogeneous reactions, interpretation of kinetic data, single and multiple reactions in ideal reactors, non-ideal reactors; residence time distribution, single parameter model; non-isothermal reactors; kinetics of heterogeneous catalytic reactions; diffusion effects in catalysis.

Instrumentation and Process Control: Measurement of process variables; sensors, transducers and their dynamics, transfer functions and dynamic responses of simple systems, process reaction curve, controller modes (P, PI, and PID); control valves; analysis of closed loop systems including stability, frequency response and controller tuning, cascade, feed forward control.

Plant Design and Economics: Process design and sizing of chemical engineering equipment such as compressors, heat exchangers, multistage contactors; principles of process economics and cost estimation including total annualized cost, cost indexes, rate of return, payback period, discounted cash flow, optimization in design.

Chemical Technology: Inorganic chemical industries; sulfuric acid, NaOH, fertilizers (Ammonia, Urea, SSP and TSP); natural products industries (Pulp and Paper, Sugar, Oil, and Fats); petroleum refining and petrochemicals; polymerization industries; polyethylene, polypropylene, PVC and polyester synthetic fibers.

7. Computer Science and Information Technology – CS

ENGINEERING MATHEMATICS

Mathematical Logic*:* Propositional Logic; First Order Logic.

Probability*:* Conditional Probability; Mean, Median, Mode and Standard Deviation; Random Variables; Distributions; uniform, normal, exponential, Poisson, Binomial.
Set Theory & Algebra*:* Sets; Relations; Functions; Groups; Partial Orders; Lattice; Boolean Algebra.

Combinatorics*:* Permutations; Combinations; Counting; Summation; generating functions;
recurrence relations; asymptotics.

Graph Theory*:* Connectivity; spanning trees; Cut vertices & edges; covering; matching; independent sets; Colouring; Planarity; Isomorphism.

Linear Algebra*:* Algebra of matrices, determinants, systems of linear equations, Eigen values and Eigen vectors.

Numerical Methods*:* LU decomposition for systems of linear equations; numerical solutions of non-linear algebraic equations by Secant, Bisection and Newton-Raphson Methods; Numerical integration by trapezoidal and Simpson's rules.

Calculus*:* Limit, Continuity & differentiability, Mean value Theorems, Theorems of integral calculus, evaluation of definite & improper integrals, Partial derivatives, Total derivatives, maxima & minima.

COMPUTER SCIENCE AND INFORMATION TECHNOLOGY

Digital Logic: Logic functions, Minimization, Design and synthesis of combinational and sequential circuits; Number representation and computer arithmetic (fixed and floating point).

Computer Organization and Architecture: Machine instructions and addressing modes, ALU and data-path, CPU control design, Memory interface, I/O interface (Interrupt and DMA mode), Instruction pipelining, Cache and main memory, Secondary storage.

Programming and Data Structures: Programming in C; Functions, Recursion, Parameter passing, Scope, Binding; Abstract data types, Arrays, Stacks, Queues, Linked Lists, Trees, Binary search trees, Binary heaps.

Algorithms: Analysis, Asymptotic notation, Notions of space and time complexity, Worst and average case analysis; Design: Greedy approach, Dynamic programming, Divide-and-conquer; Tree and graph traversals, Connected components, Spanning trees, Shortest paths; Hashing, Sorting, Searching. Asymptotic analysis (best, worst, average cases) of time and space, upper and lower bounds, Basic concepts of complexity classes – P, NP, NP-hard, NP-complete.

Theory of Computation: Regular languages and finite automata, Context free languages and Push-down automata, Recursively enumerable sets and Turing machines, Undecidability.

Compiler Design: Lexical analysis, Parsing, Syntax directed translation, Runtime environments, Intermediate and target code generation, Basics of code optimization.

Operating System: Processes, Threads, Inter-process communication, Concurrency, Synchronization, Deadlock, CPU scheduling, Memory management and virtual memory, File systems, I/O systems, Protection and security.

Databases: ER-model, Relational model (relational algebra, tuple calculus), Database design (integrity constraints, normal forms), Query languages (SQL), File structures (sequential files, indexing, B and B+ trees), Transactions and concurrency control.

Information Systems and Software Engineering: information gathering, requirement and feasibility analysis, data flow diagrams, process specifications, input/output design, process life cycle, planning and managing the project, design, coding, testing, implementation, maintenance.

Computer Networks: ISO/OSI stack, LAN technologies (Ethernet, Token ring), Flow and error control techniques, Routing algorithms, Congestion control, TCP/UDP and sockets, IP(v4), Application layer protocols (icmp, dns, smtp, pop, ftp, http); Basic concepts of hubs, switches, gateways, and routers. Network security – basic concepts of public key and private key cryptography, digital signature, firewalls.

Web technologies: HTML, XML, basic concepts of client-server computing.

8. Chemistry – CY

PHYSICAL CHEMISTRY

Structure: Quantum theory: principles and techniques; applications to a particle in a box, harmonic oscillator, rigid rotor and hydrogen atom; valence bond and molecular orbital theories, Hückel approximation; approximate techniques: variation and perturbation; symmetry, point groups; rotational, vibrational, electronic, NMR, and ESR spectroscopy

Equilibrium: Kinetic theory of gases; First law of thermodynamics, heat, energy, and work; second law of thermodynamics and entropy; third law and absolute entropy; free energy; partial molar quantities; ideal and non-ideal solutions; phase transformation: phase rule and phase diagrams - one, two, and three component systems; activity, activity coefficient, fugacity, and fugacity coefficient; chemical equilibrium, response of chemical equilibrium to temperature and pressure; colligative properties; Debye-Hückel theory; thermodynamics of electrochemical cells; standard electrode potentials: applications - corrosion and energy conversion; molecular partition function (translational, rotational, vibrational, and electronic).

Kinetics: Rates of chemical reactions, temperature dependence of chemical reactions; elementary, consecutive, and parallel reactions; steady state approximation; theories of reaction rates - collision and transition state theory, relaxation kinetics, kinetics of photochemical reactions and free radical polymerization, homogeneous catalysis, adsorption isotherms and heterogeneous catalysis.

INORGANIC CHEMISTRY

Main group elements: General characteristics, allotropes, structure and reactions of simple and industrially important compounds: boranes, carboranes, silicones, silicates, boron nitride, borazines and phosphazenes. Hydrides, oxides and oxoacids of pnictogens (N, P), chalcogens (S, Se & Te) and halogens, xenon compounds, pseudo halogens and interhalogen compounds. Shapes of molecules and hard- soft acid base concept. Structure and Bonding (VBT) of B, Al, Si, N, P, S, Cl compounds. Allotropes of carbon: graphite, diamond, C_{60}. Synthesis and reactivity of inorganic polymers of Si and P.

Transition Elements: General characteristics of d and f block elements; coordination chemistry: structure and isomerism, stability, theories of metal- ligand bonding (CFT and LFT), mechanisms of substitution and electron transfer reactions of coordination complexes. Electronic spectra and magnetic properties of transition metal complexes, lanthanides and actinides. Metal carbonyls, metal- metal bonds and metal atom clusters, metallocenes; transition metal complexes with bonds to hydrogen, alkyls, alkenes and arenes; metal carbenes; use of organometallic compounds as catalysts in organic synthesis. Bioinorganic chemistry of Na, K. Mg, Ca, Fe, Co, Zn, Cu and Mo.

Solids: Crystal systems and lattices, miller planes, crystal packing, crystal defects; Bragg's Law, ionic crystals, band theory, metals and semiconductors, Different structures of AX, AX_2, ABX_3 compounds, spinels.

Instrumental methods of analysis: Atomic absorption and emission spectroscopy including ICP-AES, UV- visible spectrophotometry, NMR, mass, Mossbauer spectroscopy (Fe and Sn), ESR spectroscopy, chromatography including GC and HPLC and electro-analytical methods (Coulometry, cyclic voltammetry, polarography – amperometry, and ion selective electrodes).

ORGANIC CHEMISTRY

Stereochemistry: Chirality of organic molecules with or without chiral centres. Specification of configuration in compounds having one or more stereogenic centres. Enantiotopic and diastereotopic atoms, groups and faces. Stereoselective and stereospecific synthesis. Conformational analysis of acyclic and cyclic compounds. Geometrical isomerism. Configurational and conformational effects on reactivity and selectivity/specificity.

Reaction mechanism: Methods of determining reaction mechanisms. Nucleophilic and electrophilic substitutions and additions to multiple bonds. Elimination reactions. Reactive intermediates- carbocations, carbanions, carbenes, nitrenes, arynes, free radicals. Molecular rearrangements involving electron deficient atoms.

Organic synthesis: Synthesis, reactions, mechanisms and selectivity involving the following- alkenes, alkynes, arenes, alcohols, phenols, aldehydes, ketones, carboxylic acids and their derivatives, halides, nitro compounds and amines. Use of compounds of Mg, Li, Cu, B and Si in organic synthesis. Concepts in multistep synthesis- retrosynthetic analysis, disconnections, synthons, synthetic equivalents, reactivity umpolung, selectivity, protection and deprotection of functional groups.

Pericyclic reactions: Electrocyclic, cycloaddition and sigmatropic reactions. Orbital correlation, FMO and PMO treatments.

Photochemistry: Basic principles. Photochemistry of alkenes, carbonyl compounds, and arenes. Photooxidation and photoreduction. Di-π- methane rearrangement, Barton reaction.

Heterocyclic compounds: Structure, preparation, properties and reactions of furan, pyrrole, thiophene, pyridine, indole and their derivatives.

Biomolecules: Structure, properties and reactions of mono- and di-saccharides, physicochemical properties of amino acids, chemical synthesis of peptides, structural features of proteins, nucleic acids, steroids, terpenoids, carotenoids, and alkaloids.

Spectroscopy: Principles and applications of UV-visible, IR, NMR and Mass spectrometry in the determination of structures of organic molecules.

9. Electronics and Communication Engineering – EC

ENGINEERING MATHEMATICS

Linear Algebra: Matrix Algebra, Systems of linear equations, Eigen values and eigen vectors.

Calculus: Mean value theorems, Theorems of integral calculus, Evaluation of definite and improper integrals, Partial Derivatives, Maxima and minima, Multiple integrals, Fourier series. Vector identities, Directional derivatives, Line, Surface and Volume integrals, Stokes, Gauss and Green's theorems.

Differential equations: First order equation (linear and nonlinear), Higher order linear differential equations with constant coefficients, Method of variation of parameters, Cauchy's and Euler's equations, Initial and boundary value problems, Partial Differential Equations and variable separable method.

Complex variables: Analytic functions, Cauchy's integral theorem and integral formula, Taylor's and Laurent' series, Residue theorem, solution integrals.

Probability and Statistics: Sampling theorems, Conditional probability, Mean, median, mode and standard deviation, Random variables, Discrete and continuous distributions, Poisson, Normal and Binomial distribution, Correlation and regression analysis.

Numerical Methods: Solutions of non-linear algebraic equations, single and multi-step methods for differential equations.

Transform Theory: Fourier transform, Laplace transform, Z-transform.

ELECTRONICS AND COMMUNICATION ENGINEERING

Networks: Network graphs: matrices associated with graphs; incidence, fundamental cut set and fundamental circuit matrices. Solution methods: nodal and mesh analysis. Network theorems: superposition, Thevenin and Norton's maximum power transfer, Wye-Delta transformation. Steady state sinusoidal analysis using phasors. Linear constant coefficient differential equations; time domain analysis of simple RLC circuits, Solution of network equations using Laplace transform: frequency domain analysis of RLC circuits. 2-port network parameters: driving point and transfer functions. State equations for networks.

Electronic Devices: Energy bands in silicon, intrinsic and extrinsic silicon. Carrier transport in silicon: diffusion current, drift current, mobility, and resistivity. Generation and recombination of carriers. p-n junction diode, Zener diode, tunnel diode, BJT, JFET, MOS capacitor, MOSFET, LED, p-I-n and avalanche photo diode, Basics of LASERs. Device technology: integrated circuits fabrication process, oxidation, diffusion, ion implantation, photolithography, n-tub, p-tub and twin-tub CMOS process.

Analog Circuits: Small Signal Equivalent circuits of diodes, BJTs, MOSFETs and analog CMOS. Simple diode circuits, clipping, clamping, rectifier. Biasing and bias stability of transistor and FET amplifiers. Amplifiers: single-and multi-stage, differential and operational, feedback, and power. Frequency response of amplifiers. Simple op-amp circuits. Filters. Sinusoidal oscillators; criterion for oscillation; single-transistor and op-amp configurations. Function generators and wave-shaping circuits, 555 Timers. Power supplies.

Digital circuits: Boolean algebra, minimization of Boolean functions; logic gates; digital IC families (DTL, TTL, ECL, MOS, CMOS). Combinatorial circuits: arithmetic circuits, code converters, multiplexers, decoders, PROMs and PLAs. Sequential circuits: latches and flip-flops, counters and shift-registers. Sample and hold circuits, ADCs, DACs. Semiconductor memories. Microprocessor(8085): architecture, programming, memory and I/O interfacing.

Signals and Systems: Definitions and properties of Laplace transform, continuous-time and discrete-time Fourier series, continuous-time and discrete-time Fourier Transform, DFT and FFT, z-transform. Sampling theorem. Linear Time-Invariant (LTI) Systems: definitions and properties; causality, stability, impulse response, convolution, poles and zeros, parallel and cascade structure, frequency response, group delay, phase delay. Signal transmission through LTI systems.

Control Systems: Basic control system components; block diagrammatic description, reduction of block diagrams. Open loop and closed loop (feedback) systems and stability analysis of these systems. Signal flow graphs and their use in determining transfer functions of systems; transient and steady state analysis of LTI control systems and frequency response. Tools and techniques for LTI control system analysis: root loci, Routh-Hurwitz criterion, Bode and Nyquist plots. Control system compensators: elements of lead and lag compensation, elements of Proportional-Integral-Derivative (PID) control. State variable representation and solution of state equation of LTI control systems.

Communications: Random signals and noise: probability, random variables, probability density function, autocorrelation, power spectral density. Analog communication systems: amplitude and angle modulation and demodulation systems, spectral analysis of these operations, superheterodyne receivers; elements of hardware, realizations of analog communication systems; signal-to-noise ratio (SNR) calculations for amplitude modulation (AM) and frequency modulation (FM) for low noise conditions. Fundamentals of information theory and channel capacity theorem. Digital communication systems: pulse code modulation (PCM), differential pulse code modulation (DPCM), digital modulation schemes: amplitude, phase and frequency shift keying schemes (ASK, PSK, FSK), matched filter receivers, bandwidth consideration and probability of error calculations for these schemes. Basics of TDMA, FDMA and CDMA and GSM.

Electromagnetics: Elements of vector calculus: divergence and curl; Gauss' and Stokes' theorems, Maxwell's equations: differential and integral forms. Wave equation, Poynting vector. Plane waves: propagation through various media; reflection and refraction; phase and group velocity; skin depth. Transmission lines: characteristic impedance; impedance transformation; Smith chart; impedance matching; S parameters, pulse excitation. Waveguides: modes in rectangular waveguides; boundary conditions; cut-off frequencies; dispersion relations. Basics of propagation in dielectric waveguide and optical fibers. Basics of Antennas: Dipole antennas; radiation pattern; antenna gain.

10. Electrical Engineering – EE

ENGINEERING MATHEMATICS

Linear Algebra: Matrix Algebra, Systems of linear equations, Eigen values and eigen vectors.

Calculus: Mean value theorems, Theorems of integral calculus, Evaluation of definite and improper integrals, Partial Derivatives, Maxima and minima, Multiple integrals, Fourier series. Vector identities, Directional derivatives, Line, Surface and Volume integrals, Stokes, Gauss and Green's theorems.

Differential equations: First order equation (linear and nonlinear), Higher order linear differential equations with constant coefficients, Method of variation of parameters, Cauchy's and Euler's equations, Initial and boundary value problems, Partial Differential Equations and variable separable method.

Complex variables: Analytic functions, Cauchy's integral theorem and integral formula, Taylor's and Laurent' series, Residue theorem, solution integrals.

Probability and Statistics: Sampling theorems, Conditional probability, Mean, median, mode and standard deviation, Random variables, Discrete and continuous distributions, Poisson, Normal and Binomial distribution, Correlation and regression analysis.

Numerical Methods: Solutions of non-linear algebraic equations, single and multi-step methods for differential equations.

Transform Theory: Fourier transform, Laplace transform, Z-transform.

ELECTRICAL ENGINEERING

Electric Circuits and Fields: Network graph, KCL, KVL, node and mesh analysis, transient response of dc and ac networks; sinusoidal steady-state analysis, resonance, basic filter concepts; ideal current and voltage sources, Thevenin's, Norton's and Superposition and Maximum Power Transfer theorems, two-port networks, three phase circuits; Gauss Theorem, electric field and potential due to point, line, plane and spherical charge distributions; Ampere's and Biot-Savart's laws; inductance; dielectrics; capacitance.

Signals and Systems: Representation of continuous and discrete-time signals; shifting and scaling operations; linear, time-invariant and causal systems; Fourier series representation of continuous periodic signals; sampling theorem; Fourier, Laplace and Z transforms.

Electrical Machines: Single phase transformer - equivalent circuit, phasor diagram, tests, regulation and efficiency; three phase transformers - connections, parallel operation; auto-transformer; energy conversion principles; DC machines - types, windings, generator characteristics, armature reaction and commutation, starting and speed control of motors; three phase induction motors - principles, types, performance characteristics, starting and speed control; single phase induction motors; synchronous machines - performance, regulation and parallel operation of generators, motor starting, characteristics and applications; servo and stepper motors.

Power Systems: Basic power generation concepts; transmission line models and performance; cable performance, insulation; corona and radio interference; distribution systems; per-unit quantities; bus impedance and admittance matrices; load flow; voltage control; power factor correction; economic operation; symmetrical components; fault analysis; principles of over-current, differential and distance protection; solid state relays and digital protection; circuit breakers; system stability concepts, swing curves and equal area criterion; HVDC transmission and FACTS concepts.

Control Systems: Principles of feedback; transfer function; block diagrams; steady-state errors; Routh and Niquist techniques; Bode plots; root loci; lag, lead and lead-lag compensation; state space model; state transition matrix, controllability and observability.

Electrical and Electronic Measurements: Bridges and potentiometers; PMMC, moving iron, dynamometer and induction type instruments; measurement of voltage, current, power, energy and power factor; instrument transformers; digital voltmeters and multimeters; phase, time and frequency measurement; Q-meters; oscilloscopes; potentiometric recorders; error analysis.

Analog and Digital Electronics: Characteristics of diodes, BJT, FET; amplifiers - biasing, equivalent circuit and frequency response; oscillators and feedback amplifiers; operational amplifiers - characteristics and applications; simple active filters; VCOs and timers; combinational and sequential logic circuits; multiplexer; Schmitt trigger; multi-vibrators; sample and hold circuits; A/D and D/A converters; 8-bit microprocessor basics, architecture, programming and interfacing.

Power Electronics and Drives: Semiconductor power diodes, transistors, thyristors, triacs, GTOs, MOSFETs and IGBTs - static characteristics and principles of operation; triggering circuits; phase control rectifiers; bridge converters - fully controlled and half controlled; principles of choppers and inverters; basis concepts of adjustable speed dc and ac drives.

11. Geology and Geophysics – GG

PART – A : COMMON TO GEOLOGY AND GEOPHYSICS

Earth and Planetary system, size, shape, internal structure and composition of the earth; atmosphere and greenhouse effect; isostasy; elements of seismology; physical properties of the interior of the earth; continents and continental processes; physical oceanography; geomagnetism and paleomagnetism, continental drift, plate tectonics.

Weathering; soil formation; action of river, wind, glacier and ocean; earthquakes, volcanism and orogeny. Basic structural geology, mineralogy and petrology. Geological time scale and geochronology; stratigraphic principles; major stratigraphic divisions of India. Engineering properties of rocks and soils. Ground water geology. Geological and geographical distribution of ore, coal and petroleum resources of India.

Introduction to remote sensing. Physical basis and applications of gravity, magnetic, electrical, electromagnetic, seismic and radiometric prospecting for oil, mineral and ground water; introductory well logging.

PART B – SECTION 1 : GEOLOGY

Crystal symmetry, forms, twinning; crystal chemistry; optical mineralogy, classification of minerals, diagnostic physical and optical properties of rock forming minerals.

Igneous rocks – classification, forms and textures, magmatic differentiation; phase diagrams and trace elements as monitors of magma evolutionary processes; mantle melting models and derivation and primary magmas. Metamorphism; controlling factors, metamorphic facies, grade and basic types; metamorphism of pelitic, mafic and impure carbonate rocks; role of fluids in metamorphism; metamorphic P-T-t paths and their tectonic significance; Igneous and metamorphic provinces of India; structure and petrology of sedimentary rocks; sedimentary processes and environments, sedimentary facies, basin analysis; association of igneous, sedimentary and metamorphic rocks with tectonic setting.

Stress, strain and material response; brittle and ductile deformation; primary and secondary structures; geometry and genesis of folds, faults, joints, unconformities; cleavage, schistosity and lineation; methods of projection, tectonites and their significance; shear zone; superposed folding; basement cover relationship.
Morphology, classification and geological significance of important invertebrates, vertebrates, microfossils and palaeoflora; stratigraphic principles and Indian stratigraphy.

Geomorphic processes and agents; development and evolution of landforms; slope and drainage; processes on deep oceanic and near-shore regions; quantitative and applied geomorphology.

Ore mineralogy and optical properties of ore minerals; ore forming processes vis-à-vis ore-rock association (magmatic, hydrothermal, sedimentary and metamorphogenic ores); ores and metamorphism; fluid inclusions as an ore genetic tool; prospecting and exploration of economic minerals; sampling, ore reserve estimation, geostatistics, mining methods. Coal and petroleum geology; origin and distribution of mineral and fuel deposits in India; marine geology and ocean resources; ore dressing and mineral economics.

Cosmic abundance; meteorites; geochemical evolution of the earth; geochemical cycles; distribution of major, minor and trace elements; elements of geochemical thermodynamics, isotope geochemistry; geochemistry of waters including solution equilibria and water rock interaction.

Engineering properties of rocks and soils; rocks as construction materials; role of geology in the construction of engineering structures including dams, tunnels and excavation sites; natural hazards. Ground water geology – exploration, well hydraulics and water quality. Basic principles of remote sensing – energy sources and radiation principles, atmospheric absorption, interaction of energy with earth's surface, air-photo interpretation, multispectral remote sensing in visible, infrared, thermal IR and microwave regions, digital processing of satellite images. GIS – basic concepts, raster and vector mode operation.

PART B – SECTION 2: GEOPHYSICS

The earth as a planet; different motions of the earth; gravity field of the earth, Clairaut's theorem, size and shape of earth; geochronology; seismology and interior of the earth; variation of density, velocity, pressure, temperature, electrical and magnetic properties of the earth; earthquakes-causes and measurements, magnitude and intensity, focal mechanisms, earthquake quantification, source characteristics, seismotectonics and seismic hazards; digital seismographs, geomagnetic field, paleomagnetism; oceanic and continental lithosphere; plate tectonics; heat flow; upper and lower atmospheric phenomena.

Scalar and vector potential fields; Laplace, Maxwell and Helmholtz equations for solution of different types of boundary value problems in Cartesian, cylindrical and spherical polar coordinates; Green's theorem; Image theory; integral equations in potential theory; Eikonal equation and Ray theory. Basic concepts of forward and inverse problems of geophysics, Ill-posedness of inverse problems.

'G' and 'g' units of measurement, absolute and relative gravity measurements; Land, airborne, shipborne and bore-hole gravity surveys; various corrections in gravity data reduction – free air, Bouguer and isostatic anomalies; density estimates of rocks; regional and residual gravity separation; principle of equivalent stratum; upward and downward continuation; wavelength filtering; preparation and analysis of gravity maps; gravity anomalies and their interpretation – anomalies due to geometrical and irregular shaped bodies, depth rules, calculation of mass.

Earth's magnetic field – elements, origin and units of measurement, magnetic susceptibility of rocks and measurements, magnetometers, Land, airborne and marine magnetic surveys, corrections, preparation of magnetic maps, upward and downward continuation, magnetic anomalies-geometrical shaped bodies, depth estimates, Image processing concepts in processing of magnetic anomaly maps; Interpretation of processed magnetic anomaly data.

Conduction of electricity through rocks, electrical conductivities of metals, non-metals, rock forming minerals and different rocks, concepts of D.C. resistivity measurement, various electrode configurations for resistivity sounding and profiling, application of filter theory, Type-curves over multi-layered structures, Dar-Zarrouck parameters, reduction of layers, coefficient of anisotropy, interpretation of resistivity field data, equivalence and suppression, self potential and its origin, field measurement, Induced polarization, time and frequency domain IP measurements; interpretation and applications of IP, ground-water exploration, environmental and engineering applications.

Basic concept of EM induction, Origin of electromagnetic field, elliptic polarization, methods of measurement for different source-receiver configuration, components in EM measurements. Skin-depth, interpretation and applications; earth's natural electromagnetic field, tellurics, magneto-tellurics; geomagnetic depth sounding principles, electromagnetic profiling, methods of measurement, processing of data and interpretation. Geological applications including groundwater, mining and hydrocarbon exploration.

Seismic methods of prospecting; Elastic properties of earth materials; Reflection, refraction and CDP surveys; land and marine seismic sources, generation and propagation of elastic waves, velocity – depth models, geophones, hydrophones, recording instruments (DFS), digital formats, field layouts, seismic noises and noise profile analysis, optimum geophone grouping, noise cancellation by shot and geophone arrays, 2D and 3D seismic data acquisition, processing and interpretation; CDP stacking charts, binning, filtering, dip-moveout, static and dynamic corrections, Digital seismic data processing, seismic deconvolution and migration methods, attribute analysis, bright and dim spots, seismic stratigraphy, high resolution seismics, VSP, AVO. Reservoir geophysics.

Geophysical signal processing, sampling theorem, aliasing, Nyquist frequency, Fourier series, periodic waveform, Fourier and Hilbert transform, Z-transform and wavelet transform; power spectrum, delta function, auto correlation, cross correlation, convolution, deconvolution, principles of digital filters, windows, poles and zeros.

Principles and techniques of geophysical well-logging. SP, resistivity, induction, gamma ray, neutron, density, sonic, temperature, dip meter, caliper, nuclear magnetic, cement bond logging, micro-logs. Quantitative evaluation of formations from well logs; well hydraulics and application of geophysical methods for groundwater study; application of bore hole geophysics in ground water, mineral and oil exploration.

Radioactive methods of prospecting and assaying of minerals (radioactive and non radioactive) deposits, half-life, decay constant, radioactive equilibrium, G M counter, scintillation detector, semiconductor devices, application of radiometric for exploration and radioactive waste disposal.

Geophysical inverse problems; non-uniqueness and stability of solutions; quasi-linear and non-linear methods including Tikhonov's regularization method, Backus-Gilbert method, simulated annealing, genetic algorithms and artificial neural network.

12. Instrumentation Engineering – IN

ENGINEERING MATHEMATICS

Linear Algebra: Matrix Algebra, Systems of linear equations, Eigen values and eigen vectors.

Calculus: Mean value theorems, Theorems of integral calculus, Evaluation of definite and improper integrals, Partial Derivatives, Maxima and minima, Multiple integrals, Fourier series. Vector identities, Directional derivatives, Line, Surface and Volume integrals, Stokes, Gauss and Green's theorems.

Differential equations: First order equation (linear and nonlinear), Higher order linear differential equations with constant coefficients, Method of variation of parameters, Cauchy's and Euler's equations, Initial and boundary value problems, Partial Differential Equations and variable separable method.

Complex variables: Analytic functions, Cauchy's integral theorem and integral formula, Taylor's and Laurent' series, Residue theorem, solution integrals.

Probability and Statistics: Sampling theorems, Conditional probability, Mean, median, mode and standard deviation, Random variables, Discrete and continuous distributions, Poisson, Normal and Binomial distribution, Correlation and regression analysis.

Numerical Methods: Solutions of non-linear algebraic equations, single and multi-step methods for differential equations.

Transform Theory: Fourier transform, Laplace transform, Z-transform.

INSTRUMENTATION ENGINEERING

Basics of Circuits and Measurement Systems: Kirchoff's laws, mesh and nodal Analysis. Circuit theorems. One-port and two-port Network Functions. Static and dynamic characteristics of Measurement Systems. Error and uncertainty analysis. Statistical analysis of data and curve fitting.

Transducers, Mechanical Measurement and Industrial Instrumentation: Resistive, Capacitive, Inductive and piezoelectric transducers and their signal conditioning. Measurement of displacement, velocity and acceleration (translational and rotational), force, torque, vibration and shock. Measurement of pressure, flow, temperature and liquid level. Measurement of pH, conductivity, viscosity and humidity.

Analog Electronics: Characteristics of diode, BJT, JFET and MOSFET. Diode circuits. Transistors at low and high frequencies, Amplifiers, single and multi-stage. Feedback amplifiers. Operational amplifiers, characteristics and circuit configurations. Instrumentation amplifier. Precision rectifier. V-to-I and I-to-V converter. Op-Amp based active filters. Oscillators and signal generators.

Digital Electronics: Combinational logic circuits, minimization of Boolean functions. IC families, TTL, MOS and CMOS. Arithmetic circuits. Comparators, Schmitt trigger, timers and mono-stable multi-vibrator. Sequential circuits, flip-flops, counters, shift registers. Multiplexer, S/H circuit. Analog-to-Digital and Digital-to-Analog converters. Basics of number system. Microprocessor applications, memory and input-output interfacing. Microcontrollers.

Signals, Systems and Communications: Periodic and aperiodic signals. Impulse response, transfer function and frequency response of first- and second order systems. Convolution, correlation and characteristics of linear time invariant systems. Discrete time system, impulse and frequency response. Pulse transfer function. IIR and FIR filters. Amplitude and frequency modulation and demodulation. Sampling theorem, pulse code modulation. Frequency and time division multiplexing. Amplitude shift keying, frequency shift keying and pulse shift keying for digital modulation.

Electrical and Electronic Measurements: Bridges and potentiometers, measurement of R,L and C. Measurements of voltage, current, power, power factor and energy. A.C & D.C current probes. Extension of instrument ranges. Q-meter and waveform analyzer. Digital voltmeter and multi-meter. Time, phase and frequency measurements. Cathode ray oscilloscope. Serial and parallel communication. Shielding and grounding.

Control Systems and Process Control: Feedback principles. Signal flow graphs. Transient Response, steady-state-errors. Routh and Nyquist criteria. Bode plot, root loci. Time delay systems. Phase and gain margin. State space representation of systems. Mechanical, hydraulic and pneumatic system components. Synchro pair, servo and step motors. On-off, cascade, P, P-I, P-I-D, feed forward and derivative controller, Fuzzy controllers.

Analytical, Optical and Biomedical Instrumentation: Mass spectrometry. UV, visible and IR spectrometry. X-ray and nuclear radiation measurements. Optical sources and detectors, LED, laser, Photo-diode, photo-resistor and their characteristics. Interferometers, applications in metrology. Basics of fiber optics. Biomedical instruments, EEG, ECG and EMG. Clinical measurements. Ultrasonic transducers and Ultrasonography. Principles of Computer Assisted Tomography.

13. Mathematics – MA

Linear Algebra: Finite dimensional vector spaces; Linear transformations and their matrix representations, rank; systems of linear equations, eigen values and eigen vectors, minimal polynomial, Cayley-Hamilton Theroem, diagonalisation, Hermitian, Skew-Hermitian and unitary matrices; Finite dimensional inner product spaces, Gram-Schmidt orthonormalization process, self-adjoint operators.

Complex Analysis: Analytic functions, conformal mappings, bilinear transformations; complex integration: Cauchy's integral theorem and formula; Liouville's theorem, maximum modulus principle; Taylor and Laurent's series; residue theorem and applications for evaluating real integrals.

Real Analysis: Sequences and series of functions, uniform convergence, power series, Fourier series, functions of several variables, maxima, minima; Riemann integration, multiple integrals, line, surface and volume integrals, theorems of Green, Stokes and Gauss; metric spaces, completeness, Weierstrass approximation theorem, compactness; Lebesgue measure, measurable functions; Lebesgue integral, Fatou's lemma, dominated convergence theorem.

Ordinary Differential Equations: First order ordinary differential equations, existence and uniqueness theorems, systems of linear first order ordinary differential equations, linear ordinary differential equations of higher order with constant coefficients; linear second order ordinary differential equations with variable coefficients; method of Laplace transforms for solving ordinary differential equations, series solutions; Legendre and Bessel functions and their orthogonality.

Algebra: Normal subgroups and homomorphism theorems, automorphisms; Group actions, Sylow's theorems and their applications; Euclidean domains, Principle ideal domains and unique factorization domains. Prime ideals and maximal ideals in commutative rings; Fields, finite fields.

Functional Analysis: Banach spaces, Hahn-Banach extension theorem, open mapping and closed graph theorems, principle of uniform boundedness; Hilbert spaces, orthonormal bases, Riesz representation theorem, bounded linear operators.

Numerical Analysis: Numerical solution of algebraic and transcendental equations: bisection, secant method, Newton-Raphson method, fixed point iteration; interpolation: error of polynomial interpolation, Lagrange, Newton interpolations; numerical differentiation; numerical integration: Trapezoidal and Simpson rules, Gauss Legendre quadrature, method of undetermined parameters; least square polynomial approximation; numerical solution of systems of linear equations: direct methods (Gauss elimination, LU decomposition); iterative methods (Jacobi and Gauss-Seidel); matrix eigenvalue problems: power method, numerical solution of ordinary differential equations: initial value problems: Taylor series methods, Euler's method, Runge-Kutta methods.

Partial Differential Equations: Linear and quasilinear first order partial differential equations, method of characteristics; second order linear equations in two variables and their classification; Cauchy, Dirichlet and Neumann problems; solutions of Laplace, wave and diffusion equations in two variables; Fourier series and Fourier transform and Laplace transform methods of solutions for the above equations.

Mechanics: Virtual work, Lagrange's equations for holonomic systems, Hamiltonian equations.

Topology: Basic concepts of topology, product topology, connectedness, compactness, countability and separation axioms, Urysohn's Lemma.

Probability and Statistics: Probability space, conditional probability, Bayes theorem, independence, Random variables, joint and conditional distributions, standard probability distributions and their properties, expectation, conditional expectation, moments; Weak and strong law of large numbers, central limit theorem; Sampling distributions, UMVU estimators, maximum likelihood estimators, Testing of hypotheses, standard parametric tests based on normal, X^2 , t, F – distributions; Linear regression; Interval estimation.

Linear programming: Linear programming problem and its formulation, convex sets and their properties, graphical method, basic feasible solution, simplex method, big-M and two phase methods; infeasible and unbounded LPP's, alternate optima; Dual problem and duality theorems, dual simplex method and its application in post optimality analysis; Balanced and unbalanced transportation problems, u -υ method for solving transportation problems; Hungarian method for solving assignment problems.

Calculus of Variation and Integral Equations: Variation problems with fixed boundaries; sufficient conditions for extremum, linear integral equations of Fredholm and Volterra type, their iterative solutions.

14. Mechanical Engineering –ME

ENGINEERING MATHEMATICS

Linear Algebra: Matrix algebra, Systems of linear equations, Eigen values and eigen vectors.

Calculus: Functions of single variable, Limit, continuity and differentiability, Mean value theorems, Evaluation of definite and improper integrals, Partial derivatives, Total derivative, Maxima and minima, Gradient, Divergence and Curl, Vector identities, Directional derivatives, Line, Surface and Volume integrals, Stokes, Gauss and Green's theorems.

Differential equations: First order equations (linear and nonlinear), Higher order linear differential equations with constant coefficients, Cauchy's and Euler's equations, Initial and boundary value problems, Laplace transforms, Solutions of one dimensional heat and wave equations and Laplace equation.

Complex variables: Analytic functions, Cauchy's integral theorem, Taylor and Laurent series.

Probability and Statistics: Definitions of probability and sampling theorems, Conditional probability, Mean, median, mode and standard deviation, Random variables, Poisson, Normal and Binomial distributions.

Numerical Methods: Numerical solutions of linear and non-linear algebraic equations Integration by trapezoidal and Simpson's rule, single and multi-step methods for differential equations.

APPLIED MECHANICS AND DESIGN

Engineering Mechanics: Free body diagrams and equilibrium; trusses and frames; virtual work; kinematics and dynamics of particles and of rigid bodies in plane motion, including impulse and momentum (linear and angular) and energy formulations; impact.

Strength of Materials: Stress and strain, stress-strain relationship and elastic constants, Mohr's circle for plane stress and plane strain, thin cylinders; shear force and bending moment diagrams; bending and shear stresses; deflection of beams; torsion of circular shafts; Euler's theory of columns; strain energy methods; thermal stresses.

Theory of Machines: Displacement, velocity and acceleration analysis of plane mechanisms; dynamic analysis of slider-crank mechanism; gear trains; flywheels.

Vibrations: Free and forced vibration of single degree of freedom systems; effect of damping; vibration isolation; resonance, critical speeds of shafts.

Design: Design for static and dynamic loading; failure theories; fatigue strength and the S-N diagram; *principles* of the design of machine elements such as bolted, riveted and welded joints, shafts, spur gears, rolling and sliding contact bearings, brakes and clutches.

FLUID MECHANICS AND THERMAL SCIENCES

Fluid Mechanics: Fluid properties; fluid statics, manometry, buoyancy; control-volume analysis of mass, momentum and energy; fluid acceleration; differential equations of continuity and momentum; Bernoulli's equation; viscous flow of incompressible fluids; boundary layer; elementary turbulent flow; flow through pipes, head losses in pipes, bends etc.

Heat-Transfer: Modes of heat transfer; one dimensional heat conduction, resistance concept, electrical analogy, unsteady heat conduction, fins; dimensionless parameters in free and forced convective heat transfer, various correlations for heat transfer in flow over flat plates and through pipes; thermal boundary layer; effect of turbulence; radiative heat transfer, black and grey surfaces, shape factors, network analysis; heat exchanger performance, LMTD and NTU methods.

Thermodynamics: Zeroth, First and Second laws of thermodynamics; thermodynamic system and processes; Carnot cycle. irreversibility and availability; behaviour of ideal and real gases, properties of pure substances, calculation of work and heat in ideal processes; analysis of thermodynamic cycles related to energy conversion.

Applications: *Power Engineering*: Steam Tables, Rankine, Brayton cycles with regeneration and reheat. *I.C. Engines*: air-standard Otto, Diesel cycles. *Refrigeration and air-conditioning*: Vapour refrigeration cycle, heat pumps, gas refrigeration, Reverse Brayton cycle; moist air: psychrometric chart, basic psychrometric processes. *Turbomachinery:* Pelton-wheel, Francis and Kaplan turbines — impulse and reaction principles, velocity diagrams.

MANUFACTURING AND INDUSTRIAL ENGINEERING

Engineering Materials: Structure and properties of engineering materials, heat treatment, stress-strain diagrams for engineering materials.

Metal Casting: Design of patterns, moulds and cores; solidification and cooling; riser and gating design, design considerations.

Forming: Plastic deformation and yield criteria; fundamentals of hot and cold working processes; load estimation for bulk (forging, rolling, extrusion, drawing) and sheet (shearing, deep drawing, bending) metal forming processes; principles of powder metallurgy.

Joining: Physics of welding, brazing and soldering; adhesive bonding; design considerations in welding.

Machining and Machine Tool Operations: Mechanics of machining, single and multi-point cutting tools, tool geometry and materials, tool life and wear; economics of machining; principles of non-traditional machining processes; principles of work holding, principles of design of jigs and fixtures

Metrology and Inspection: Limits, fits and tolerances; linear and angular measurements; comparators; gauge design; interferometry; form and finish measurement; alignment and testing methods; tolerance analysis in manufacturing and assembly.

Computer Integrated Manufacturing: Basic concepts of CAD/CAM and their integration tools.

Production Planning and Control: Forecasting models, aggregate production planning, scheduling, materials requirement planning.

Inventory Control: Deterministic and probabilistic models; safety stock inventory control systems.

Operations Research: Linear programming, simplex and duplex method, transportation, assignment, network flow models, simple queuing models, PERT and CPM.

15. Mining Engineering – MN

ENGINEERING MATHEMATICS

Linear Algebra*:* Matrices and Determinants, Systems of linear equations, Eigen values and Eigen vectors.
Calculus: Limit, continuity and differentiability; Partial Derivatives; Maxima and minima; Sequences and series; Test for convergence; Fourier series.

Vector Calculus: Gradient; Divergence and Curl; Line; surface and volume integrals; Stokes, Gauss and Green's theorems.

Diferential Equations: Linear and non-linear first order ODEs; Higher order linear ODEs with constant coefficients; Cauchy's and Euler's equations; Laplace transforms; PDEs – Laplace, heat and wave equations.

Probability and Statistics: Mean, median, mode and standard deviation; Random variables; Poisson, normal and binomial distributions; Correlation and regression analysis.

Numerical Methods: Solutions of linear and non-linear algebraic equations; integration of trapezoidal and Simpson's rule; single and multi-step methods for differential equations.

MINING ENGINEERING

Mechanics: Equivalent force systems; Equations of equilibrium; Two dimensional frames and trusses; Free body diagrams; Friction forces; Particle kinematics and dynamics.

Mine Development, Geomechanics and Ground Control: Methods of access to deposits; Underground drivages; Drilling methods and machines; Explosives, blasting devices and practices.
Geo-technical properties of rocks; Rock mass classification; Ground control, instrumentation and stress measurement techniques; Theories of rock failure; Ground vibrations; Stress distribution around mine openings; Subsidence; Design of supports in roadways and workings; Rock bursts and coal bumps; Slope stability.

Mining Methods and Machinery: Surface mining: layout, development, loading, transportation and mechanization, continuous surface mining systems; Underground coal mining: bord and pillar systems, room and pillar mining, longwall mining, thick seam mining methods; Underground metal mining : open, supported and caved stoping methods, stope mechanization, ore handling systems, mine filling.
Generation and transmission of mechanical, hydraulic and pneumatic power; Materials handling: haulages, conveyors, face and development machinery, hoisting systems, pumps.

Ventilation, Underground Hazards and Surface Environment: Underground atmosphere; Heat load sources and thermal environment, air cooling; Mechanics of air flow, distribution, natural and mechanical ventilation; Mine fans and their usage; Auxiliary ventilation; Ventilation planning.

Subsurface hazards from fires, explosions, gases, dust and inundation; Rescue apparatus and practices; Safety in mines, accident analysis, noise, mine lighting, occupational health and risk.

Air, water and soil pollution : causes, dispersion, quality standards, reclamation and control.

Surveying, Mine Planning and Systems Engineering: Fundamentals of engineering surveying; Levels and leveling, theodolite, tacheometry, triangulation, contouring, errors and adjustments, correlation; Underground surveying; Curves;

Photogrammetry; Field astronomy; EDM, total station and GPS fundamentals.

Principles of planning: Sampling methods and practices, reserve estimation techniques, basics of geostatistics and quality control, optimization of facility location, cash flow concepts and mine valuation, open pit design; GIS fundamentals.

Work-study; Concepts of reliability, reliability of series and parallel systems.

Linear programming, transportation and assignment problems, queueing, network analysis, basics of simulation.

16. Metallurgical Engineering – MT

ENGINEERING MATHEMATICS

Linear Algebra*:* Matrices and Determinants, Systems of linear equations, Eigen values and Eigen vectors.

Calculus: Limit, continuity and differentiability; Partial Derivatives; Maxima and minima; Sequences and series; Test for convergence; Fourier series.

Vector Calculus: Gradient; Divergence and Curl; Line; surface and volume integrals; Stokes, Gauss and Green's theorems.

Diferential Equations: Linear and non-linear first order ODEs; Higher order linear ODEs with constant coefficients; Cauchy's and Euler's equations; Laplace transforms; PDEs – Laplace, heat and wave equations.

Probability and Statistics: Mean, median, mode and standard deviation; Random variables; Poisson, normal and binomial distributions; Correlation and regression analysis.

Numerical Methods: Solutions of linear and non-linear algebraic equations; integration of trapezoidal and Simpson's rule; single and multi-step methods for differential equations.

METALLURGICAL ENGINEERING

Thermodynamics and Rate Processes: Laws of thermodynamics, activity, equilibrium constant, applications to metallurgical systems, solutions, phase equilibria, Ellingham and phase stability diagrams, thermodynamics of surfaces, interfaces and defects, adsorption and segregation; basic kinetic laws, order of reactions, rate constants and rate limiting steps; principles of electro chemistry- single electrode potential, electro-chemical cells and polarizations, aqueous corrosion and protection of metals, oxidation and high temperature corrosion – characterization and control; heat transfer – conduction, convection and heat transfer coefficient relations, radiation, mass transfer – diffusion and Fick's laws, mass transfer coefficients; momentum transfer – concepts of viscosity, shell balances, Bernoulli's equation, friction factors.

Extractive Metallurgy: Minerals of economic importance, comminution techniques, size classification, Flotation, gravity and other methods of mineral processing; agglomeration, pyro- hydro- and electro-metallurgical processes; material and energy balances; principles and processes for the extraction of non-ferrous metals – aluminium, copper, zinc, lead, magnesium, nickel, titanium and other rare metals; iron and steel making – principles, role structure and properties of slags, metallurgical coke, blast furnace, direct reduction processes, primary and secondary steel making, ladle metallurgy operations including deoxidation, desulphurization, sulphide shape control, inert gas rinsing and vacuum reactors; secondary refining processes including AOD, VAD, VOD, VAR and ESR; ingot and continuous casting; stainless steel making, furnaces and refractories.

Physical Metallurgy: Crystal structure and bonding characteristics of metals, alloys, ceramics and polymers, structure of surfaces and interfaces, nano-crystalline and amorphous structures; solid solutions; solidification; phase transformation and binary phase diagrams; principles of heat treatment of steels, cast iron and aluminum alloys; surface treatments; recovery, recrystallization and grain growth; industrially important ferrous and non-ferrous alloys; elements of X-ray and electron diffraction; principles of scanning and transmission electron microscopy; industrial ceramics, polymers and composites; electronic basis of thermal, optical, electrical and magnetic properties of materials; electronic and opto-electronic materials.

Mechanical Metallurgy: Elasticity, yield criteria and plasticity; defects in crystals; elements of dislocation theory – types of dislocations, slip and twinning, source and multiplication of dislocations, stress fields around dislocations, partial dislocations, dislocation interactions and reactions; strengthening mechanisms; tensile, fatigue and creep behaviour; super-plasticity; fracture – Griffith theory, basic concepts of linear elastic and elasto-plastic fracture mechanics, ductile to brittle transition, fracture toughness; failure analysis; mechanical testing – tension, compression, torsion, hardness, impact, creep, fatigue, fracture toughness and formability.

Manufacturing Processes: Metal casting – patterns and moulds including mould design involving feeding, gating and risering, melting, casting practices in sand casting, permanent mould casting, investment casting and shell moulding, casting defects and repair; hot, warm and cold working of metals, Metal forming - fundamentals of metal forming processes of rolling, forging, extrusion, wire drawing and sheet metal forming, defects in forming; Metal joining - soldering, brazing and welding, common welding processes of shielded metal arc welding, gas metal arc welding, gas tungsten arc welding and submerged arc welding; welding metallurgy, problems associated with welding of steels and aluminium alloys, defects in welded joints; powder metallurgy; NDT using dye-penetrant, ultrasonic, radiography, eddy current, acoustic emission and magnetic particle methods.

17. Physics – PH

Mathematical Physics: Linear vector space; matrices; vector calculus; linear differential equations; elements of complex analysis; Laplace transforms, Fourier analysis, elementary ideas about tensors.

Classical Mechanics: Conservation laws; central forces, Kepler problem and planetary motion; collisions and scattering in laboratory and centre of mass frames; mechanics of system of particles; rigid body dynamics; moment of inertia tensor; noninertial frames and pseudo forces; variational principle; Lagrange's and Hamilton's formalisms; equation of motion, cyclic coordinates, Poisson bracket; periodic motion, small oscillations, normal modes; special theory of relativity – Lorentz transformations, relativistic kinematics, mass-energy equivalence.

Electromagnetic Theory: Solution of electrostatic and magnetostatic problems including boundary value problems; dielectrics and conductors; Biot-Savart's and Ampere's laws; Faraday's law; Maxwell's equations; scalar and vector potentials; Coulomb and Lorentz gauges; Electromagnetic waves and their reflection, refraction, interference, diffraction and polarization. Poynting vector, Poynting theorem, energy and momentum of electromagnetic waves; radiation from a moving charge.

Quantum Mechanics: Physical basis of quantum mechanics; uncertainty principle; Schrodinger equation; one, two and three dimensional potential problems; particle in a box, harmonic oscillator, hydrogen atom; linear vectors and operators in Hilbert space; angular momentum and spin; addition of angular momenta; time independent perturbation theory; elementary scattering theory.

Thermodynamics and Statistical Physics: Laws of thermodynamics; macrostates and microstates; phase space; probability ensembles; partition function, free energy, calculation of thermodynamic quantities; classical and quantum statistics; degenerate Fermi gas; black body radiation and Planck's distribution law; Bose-Einstein condensation; first and second order phase transitions, critical point.

Atomic and Molecular Physics: Spectra of one- and many-electron atoms; LS and jj coupling; hyperfine structure; Zeeman and Stark effects; electric dipole transitions and selection rules; X-ray spectra; rotational and vibrational spectra of diatomic molecules; electronic transition in diatomic molecules, Franck-Condon principle; Raman effect; NMR and ESR; lasers.

Solid State Physics: Elements of crystallography; diffraction methods for structure determination; bonding in solids; elastic properties of solids; defects in crystals; lattice vibrations and thermal properties of solids; free electron theory; band theory of solids; metals, semiconductors and insulators; transport properties; optical, dielectric and magnetic properties of solids; elements of superconductivity.

Nuclear and Particle Physics: Nuclear radii and charge distributions, nuclear binding energy, Electric and magnetic moments; nuclear models, liquid drop model - semi-empirical mass formula, Fermi gas model of nucleus, nuclear shell model; nuclear force and two nucleon problem; Alpha decay, Beta-decay, electromagnetic transitions in nuclei; Rutherford scattering, nuclear reactions, conservation laws; fission and fusion; particle accelerators and detectors; elementary particles, photons, baryons, mesons and leptons; quark model.

Electronics: Network analysis; semiconductor devices; Bipolar Junction Transistors, Field Effect Transistors, amplifier and oscillator circuits; operational amplifier, negative feedback circuits , **active filters and oscillators**; rectifier circuits, regulated power supplies; basic digital logic circuits, sequential circuits, flip-flops, counters, registers, A/D and D/A conversion.

18. Production and Industrial Engineering – PI

ENGINEERING MATHEMATICS

Linear Algebra*:* Matrix algebra, Systems of linear equations, Eigen values and eigen vectors.

Calculus*:* Functions of single variable, Limit, continuity and differentiability, Mean value theorems, Evaluation of definite and improper integrals, Partial derivatives, Total derivative, Maxima and minima, Gradient, Divergence and Curl, Vector identities, Directional derivatives, Line, Surface and Volume integrals, Stokes, Gauss and Green's theorems.

Differential equations*:* First order equations (linear and nonlinear), Higher order linear differential equations with constant coefficients, Cauchy's and Euler's equations, Initial and boundary value problems, Laplace transforms, Solutions of one dimensional heat and wave equations and Laplace equation.

Complex variables*:* Analytic functions, Cauchy's integral theorem, Taylor and Laurent series.

Probability and Statistics*:* Definitions of probability and sampling theorems, Conditional probability, Mean, median, mode and standard deviation, Random variables, Poisson, Normal and Binomial distributions.

Numerical Methods*:* Numerical solutions of linear and non-linear algebraic equations Integration by trapezoidal and Simpson's rule, single and multi-step methods for differential equations.

GENERAL ENGINEERING

Engineering Materials: Structure and properties of engineering materials and their applications; effect of strain, strain rate and temperature on mechanical properties of metals and alloys; heat treatment of metals and alloys, its influence on mechanical properties.

Applied Mechanics: Engineering mechanics - equivalent force systems, free body concepts, equations of equilibrium; strength of materials - stress, strain and their relationship, Mohr's circle, deflection of beams, bending and shear stress, Euler's theory of columns.

Theory of Machines and Design: Analysis of planar mechanisms, cams and followers; governers and fly wheels; design of elements - failure theories; design of bolted, riveted and welded joints; design of shafts, keys, spur gears, belt drives, brakes and clutches.

Thermal Engineering: Fluid mechanics - fluid statics, Bernoulli's equation, flow through pipes, equations of continuity and momentum; thermodynamics - zeroth, first and second law of thermodynamics, thermodynamic system and processes, calculation of work and heat for systems and control volumes; air standard cycles; basics of internal combustion engines and steam turbines; heat transfer - fundamentals of conduction, convection and radiation, heat exchangers.

PRODUCTION ENGINEERING

Metal Casting: Casting processes - types and applications; patterns - types and materials; allowances; moulds and cores - materials, making, and testing; casting techniques of cast iron, steels and nonferrous metals and alloys; solidification; design of casting, gating and risering; casting inspection, defects and remedies.

Metal Forming: Stress-strain relations in elastic and plastic deformation; concept of flow stress, deformation mechanisms; hot and cold working - forging, rolling, extrusion, wire and tube drawing; sheet metal working processes such as blanking, piercing, bending, deep drawing, coining and embossing; analysis of rolling, forging, extrusion and wire /rod drawing; metal working defects.

Metal Joining Processes: Welding processes - manual metal arc, MIG, TIG, plasma arc, submerged arc, electroslag, thermit, resistance, forge, friction, and explosive welding;other joining processes - soldering, brazing, braze welding; inspection of welded joints, defects and remedies; introduction to advanced welding processes - ultrasonic, electron beam, laser beam; thermal cutting.

Machining and Machine Tool Operations: Basic machine tools; machining processes-turning, drilling, boring, milling, shaping, planing, gear cutting, thread production, broaching, grinding, lapping, honing, super finishing; mechanics of machining - geometry of cutting tools, chip formation, cutting forces and power requirements, Merchant's analysis; selection of machining parameters; tool materials, tool wear and tool life, economics of machining, thermal aspects of machining, cutting fluids, machinability; principles and applications of nontraditional machining processes - USM, AJM, WJM, EDM and Wire cut EDM, LBM, EBM, PAM, CHM, ECM.

Tool Engineering: Jigs and fixtures - principles, applications, and design; press tools - configuration, design of die and punch; principles of forging die design.

Metrology and Inspection: Limits, fits, and tolerances, interchangeability, selective assembly; linear and angular measurements by mechanical and optical methods, comparators; design of limit gauges; interferometry; measurement of straightness, flatness, roundness, squareness and symmetry; surface finish measurement; inspection of screw threads and gears; alignment testing of machine tools.

Powder Metallurgy: Production of metal powders, compaction and sintering.

Polymers and Composites: Introduction to polymers and composites; plastic processing - injection, compression and blow molding, extrusion, calendaring and thermoforming; molding of composites.

Manufacturing Analysis: Sources of errors in manufacturing; process capability; tolerance analysis in manufacturing and assembly; process planning; parameter selection and comparison of production alternatives; time and cost analysis; manufacturing technologies - strategies and selection.
Computer Integrated Manufacturing: Basic concepts of CAD, CAM, CAPP, cellular manufacturing, NC, CNC, DNC, Robotics, FMS, and CIM.

INDUSTRIAL ENGINEERING

Product Design and Development: Principles of good product design, tolerance design; quality and cost considerations; product life cycle; standardization, simplification, diversification, value engineering and analysis, concurrent engineering.

Engineering Economy and Costing: Elementary cost accounting and methods of depreciation; break-even analysis, techniques for evaluation of capital investments, financial statements.

Work System Design: Taylor's scientific management, Gilbreths's contributions; productivity - concepts and measurements; method study, micro-motion study, principles of motion economy; work measurement - stop watch time study, work sampling, standard data, PMTS; ergonomics; job evaluation, merit rating, incentive schemes, and wage administration; business process reengineering.

Facility Design: Facility location factors and evaluation of alternate locations; types of plant layout and their evaluation; computer aided layout design techniques; assembly line balancing; materials handling systems.

Production Planning and Inventory Control: Forecasting techniques - causal and time series models, moving average, exponential smoothing, trend and seasonality; aggregate production planning; master production scheduling; MRP and MRP-II; order control and flow control; routing, scheduling and priority dispatching; push and pull production systems, concept of JIT manufacturing system; logistics, distribution, and supply chain management; Inventory - functions, costs, classifications, deterministic and probabilistic inventory models, quantity discount; perpetual and periodic inventory control systems.

Operation Research: Linear programming - problem formulation, simplex method, duality and sensitivity analysis; transportation and assignment models; network flow models, constrained optimization and Lagrange multipliers; simple queuing models; dynamic programming; simulation - manufacturing applications; PERT and CPM, time-cost trade-off, resource leveling.

Quality Management: Quality - concept and costs, quality circles, quality assurance; statistical quality control, acceptance sampling, zero defects, six sigma; total quality management; ISO 9000; design of experiments - Taguchi method.

Reliability and Maintenance: Reliability, availability and maintainability; distribution of failure and repair times; determination of MTBF and MTTR, reliability models; system reliability determination; preventive maintenance and replacement, total productive maintenance - concept and applications.

Management Information System: Value of information; information storage and retrieval system - database and data structures; knowledge based systems.

Intellectual Property System: Definition of intellectual property, importance of IPR; TRIPS and its implications, patent, copyright, industrial design and trademark.

19. Textile Engineering and Fibre Science – TF

ENGINEERING MATHEMATICS

Linear Algebra*:* Matrices and Determinants, Systems of linear equations, Eigen values and eigen vectors.

Calculus: Limit, continuity and differentiability; Partial Derivatives; Maxima and minima; Sequences and series; Test for convergence; Fourier series.

Vector Calculus: Gradient; Divergence and Curl; Line; surface and volume integrals; Stokes, Gauss and Green's theorems.

Diferential Equations: Linear and non-linear first order ODEs; Higher order linear ODEs with constant coefficients; Cauchy's and Euler's equations; Laplace transforms; PDEs – Laplace, heat and wave equations.

Probability and Statistics: Mean, median, mode and standard deviation; Random variables; Poisson, normal and binomial distributions; Correlation and regression analysis.

Numerical Methods: Solutions of linear and non-linear algebraic equations; integration of trapezoidal and Simpson's rule; single and multi-step methods for differential equations.

TEXTILE ENGINEERING AND FIBRE SCIENCE

Textile Fibres: Classification of textile fibres; Essential requirements of fibre forming polymers; Gross and fine structure of natural fibres like cotton, wool and silk. Introduction to important bast fibres; properties and uses of natural and man-made fibres; physical and chemical methods of fibre and blend identification and blend analysis.
Molecular architecture, amorphous and crystalline phases, glass transition, plasticization, crystallization, melting, factors affecting T_g and T_m; Process of viscose and acetate preparation. Polymerization of nylon-6, nylon-66, poly (ethylene terephthalate), polyacrylonitrile and polypropylene; Melt Spinning processes, characteristic features of PET, polyamide and polypropylene spinning; wet and dry spinning of viscose and acrylic fibres; post spinning operations such as drawing, heat setting, tow-to-top conversion and different texturing methods.

Methods of investigating fibre structure e.g., Density, X-ray diffraction, birefringence, optical and electron microscopy, I.R. absorption, thermal methods (DSC, DMA/TMA, TGA); structure and morphology of man-made fibres, mechanical properties of fibres, moisture sorption in fibres; fibre structure and property correlation.

Yarn manufacture and yarn structure & properties: Principles of opening, cleaning and mixing/blending of fibrous materials, working principle of modern opening and cleaning equipments; the technology of carding, carding of cotton and synthetic fibres; Drafting operation, roller and apron drafting principle, causes of mass irregularity introduced by drafting; roller arrangements in drafting systems; principles of cotton combing, combing cycle, mechanism and function, combing efficiency, lap preparation; recent developments in comber; Roving production, mechanism of bobbin building, roving twist; Principle of ring spinning, forces acting on yarn and traveler; ring & traveler designs; mechanism of cop formation, causes of end breakages; working principle of ring doubler and two for one twister, single and folded yarn twist, properties of double yarns, production of core spun yarn, compact spinning, principle of non conventional methods of yarn production such as rotor spinning, air jet spinning, wrap spinning, twist less spinning and friction spinning.

Yarn contraction, yarn diameter, specific volume & packing coefficient; twist strength relationship in spun yarns; fibre configuration and orientation in yarn; cause of fibre migration and its estimation, irregularity index, properties of ring, rotor and air-jet yarns.

Fabric manufacture and Fabric Structure: Principles of cheese and cone winding processes and machines; random and precision winding; package faults and their remedies; yarn clearers and tensioners; different systems of yarn splicing; features of modern cone winding machines; different types of warping creels; features of modern beam and sectional warping machines; different sizing systems, sizing of spun and filament yarns, modern sizing machines; principles of pirn winding processes and machines; primary and secondary motions of loom, effect of their settings and timings on fabric formation, fabric appearance and weaving performance; dobby and jacquard shedding; mechanics of weft insertion with shuttle; warp and weft stop motions, warp protection, weft replenishment; functional principles of weft insertion systems of shuttle-less weaving machines, principles of multiphase and circular looms.

Principles of weft and warp knitting; basic weft and warp knitted structures. Classification, production and areas of application of nonwoven fabrics. Basic woven fabric constructions and their derivatives; crepe, cord, terry, gauze, leno and double cloth constructions. Peirce's equations for fabric geometry; elastica model of plain woven fabrics; thickness, cover and maximum sett of woven fabrics.

Textile Testing: Sampling techniques, sample size and sampling errors. Measurement of fibre length, fineness, crimp, strength and reflectance; measurement of cotton fibre maturity and trash content; HVI and AFIS for fibre testing. Measurement of yarn count, twist and hairiness; tensile testing of fibres, yarns and fabrics; evenness testing of slivers, rovings and yarns; testing equipment for measurement test methods of fabric properties like thickness, compressibility, air permeability, drape, crease recovery, tear strength, bursting strength and abrasion resistance. FAST and Kawabata instruments and systems for objective fabric evaluation. Statistical data analysis of experimental results. Correlation analysis, significance tests and analysis of variance; frequency distributions and control charts.

Preparatory Processes: Chemistry and practice of preparatory processes for cotton, wool and silk. Mercerization of cotton. Preparatory processes for nylon, polyester and acrylic and polyester/cotton blends.

Dyeing: Classification of dyes. Dyeing of cotton, wool, silk, polyester, nylon and acrylic with appropriate dye classes. Dyeing polyester/cotton and polyester/wool blends. Batchwise and continuous dyeing machines. Dyeing of cotton knitted fabrics and machines used. Dye fibre interaction. Introduction to thermodynamics and kinetics of dyeing. Methods for determination of wash, light and rubbing fastness. Evaluation of fastness properties with the help of grey scale.

Printing: Styles of printing. Printing thickeners including synthetic thickeners. Printing auxiliaries. Printing of cotton with reactive dyes. Printing of wool, silk, nylon with acid and metal complex dyes. Printing of polyester with disperse dyes. Methods of dye fixation after printing. Resist and discharge printing of cotton, silk and polyester. Printing of polyester/cotton blends with disperse/reactive combination. Transfer printing of polyester. Developments in inkjet printing.

Finishing: Mechanical finishing of cotton**.** Stiff. Soft, wrinkle resistant, water repellent, flame retardant and enzyme (bio-polishing) finishing of cotton. Milling, decatizing and shrink resistant finishing of wool. Antistat finishing of synthetic fibre fabrics. Heat setting of polyester.

Energy Conservation: Minimum application techniques.

Pollution: Environment pollution during chemical processing of textiles. Treatment of textile effluents.

20. Engineering Sciences – XE

SECTION A: ENGINEERING MATHEMATICS (Compulsory)

Linear Algebra: Algebra of matrices, inverse, rank, system of linear equations, symmetric, skew-symmetric and orthogonal matrices. Hermitian, skew-Hermitian and unitary matrices. eigenvalues and eigenvectors, diagonalisation of matrices, Cayley-Hamilton Theorem.

Calculus: Functions of single variable, limit, continuity and differentiability, Mean value theorems, Indeterminate forms and L'Hospital rule, Maxima and minima, Taylor's series, Fundamental and mean value-theorems of integral calculus. Evaluation of definite and improper integrals, Beta and Gamma functions, Functions of two variables, limit, continuity, partial derivatives, Euler's theorem for homogeneous functions, total derivatives, maxima and minima, Lagrange method of multipliers, double and triple integrals and their applications, sequence and series, tests for convergence, power series, Fourier Series, Half range sine and cosine series.

Complex variable: Analytic functions, Cauchy-Riemann equations, Application in solving potential problems, Line integral, Cauchy's integral theorem and integral formula (without proof), Taylor's and Laurent' series, Residue theorem (without proof) and its applications.

Vector Calculus: Gradient, divergence and curl, vector identities, directional derivatives, line, surface and volume integrals, Stokes, Gauss and Green's theorems (without proofs) applications.

Ordinary Differential Equations: First order equation (linear and nonlinear), Second order linear differential equations with variable coefficients, Variation of parameters method, higher order linear differential equations with constant coefficients, Cauchy- Euler's equations, power series solutions, Legendre polynomials and Bessel's functions of the first kind and their properties.

Partial Differential Equations: Separation of variables method, Laplace equation, solutions of one dimensional heat and wave equations.

Probability and Statistics: Definitions of probability and simple theorems, conditional probability, Bayes Theorem, random variables, discrete and continuous distributions, Binomial, Poisson, and normal distributions, correlation and linear regression.

Numerical Methods: Solution of a system of linear equations by L-U decomposition, Gauss-Jordan and Gauss-Seidel Methods, Newton's interpolation formulae, Solution of a polynomial and a transcendental equation by Newton-Raphson method, numerical integration by trapezoidal rule, Simpson's rule and Gaussian quadrature, numerical solutions of first order differential equation by Euler's method and 4^{th} order Runge-Kutta method.

SECTION B: FLUID MECHANICS

Fluid Properties: Relation between stress and strain rate for Newtonian fluids.

Hydrostatics: Buoyancy, manometry, forces on submerged bodies.

Eulerian and Lagrangian description of fluid motion, concept of local and convective accelerations, steady and unsteady flows, control volume analysis for mass, momentum and energy.

Differential equations of mass and momentum (Euler equation), Bernoulli's equation and its applications.

Concept of fluid rotation, vorticity, stream function and potential function.

Potential flow: elementary flow fields and principle of superposition, potential flow past a circular cylinder.

Dimensional analysis: Concept of geometric, kinematic and dynamic similarity, importance of non-dimensional numbers.

Fully-developed pipe flow, laminar and turbulent flows, friction factor, Darcy-Weisbach relation.
Qualitative ideas of boundary layer and separation, streamlined and bluff bodies, drag and lift forces.

Basic ideas of flow measurement using venturimeter, pitot-static tube and orifice plate.

SECTION C: MATERIALS SCIENCE

Structure: Atomic structure and bonding in materials. Crystal structure of materials, crystal systems, unit cells and space lattices, determination of structures of simple crystals by x-ray diffraction, miller indices of planes and directions, packing geometry in metallic, ionic and covalent solids. Concept of amorphous, single and polycrystalline structures and their effect on properties of materials. Crystal growth techniques. Imperfections in crystalline solids and their role in influencing various properties.

Diffusion: Fick's laws and application of diffusion in sintering, doping of semiconductors and surface hardening of metals.

Metals and Alloys: Solid solutions, solubility limit, phase rule, binary phase diagrams, intermediate phases, intermetallic compounds, iron-iron carbide phase diagram, heat treatment of steels, cold, hot working of metals, recovery, recrystallization and grain growth. Microstrcture, properties and applications of ferrous and non-ferrous alloys.

Ceramics: Structure, properties, processing and applications of traditional and advanced ceramics.

Polymers: Classification, polymerization, structure and properties, additives for polymer products, processing and applications.

Composites: Properties and applications of various composites.

Advanced Materials and Tools: Smart materials, exhibiting ferroelectric, piezoelectric, optoelectric, semiconducting behavior, lasers and optical fibers, photoconductivity and superconductivity, nanomaterials – synthesis, properties and applications, biomaterials, superalloys, shape memory alloys. Materials characterization techniques such as, scanning electron microscopy, transmission electron microscopy, atomic force microscopy, scanning tunneling microscopy, atomic absorption spectroscopy, differential scanning calorimetry.

Mechanical Properties: stress-strain diagrams of metallic, ceramic and polymeric materials, modulus of elasticity, yield strength, tensile strength, toughness, elongation, plastic deformation, viscoelasticity, hardness, impact strength, creep, fatigue, ductile and brittle fracture.

Thermal Properties: Heat capacity, thermal conductivity, thermal expansion of materials.

Electronic Properties: Concept of energy band diagram for materials - conductors, semiconductors and insulators, electrical conductivity – effect of temperature on conductility, intrinsic and extrinsic semiconductors, dielectric properties.

Optical Properties: Reflection, refraction, absorption and transmission of electromagnetic radiation in solids.

Magnetic Properties: Origin of magnetism in metallic and ceramic materials, paramagnetism, diamagnetism, antiferro magnetism, ferromagnetism, ferrimagnetism, magnetic hysterisis.

Environmental Degradation: Corrosion and oxidation of materials, prevention.

SECTION D: SOLID MECHANICS
Equivalent force systems; free-body diagrams; equilibrium equations; analysis of determinate trusses and frames; friction; simple relative motion of particles; force as function of position, time and speed; force acting on a body in motion; laws of motion; law of conservation of energy; law of conservation of momentum.

Stresses and strains; principal stresses and strains; Mohr's circle; generalized Hooke's Law; thermal strain; theories of failure. Axial, shear and bending moment diagrams; axial, shear and bending stresses; deflection (for symmetric bending); torsion in circular shafts; thin cylinders; energy methods (Castigliano's Theorems); Euler buckling.
Free vibration of single degree of freedom systems.

SECTION E: THERMODYNAMICS

Basic Concepts: Continuum, macroscopic approach, thermodynamic system (closed and open or control volume); thermodynamic properties and equilibrium; state of a system, state diagram, path and process; different modes of work; Zeroth law of thermodynamics; concept of temperature; heat.

First Law of Thermodynamics: Energy, enthalpy, specific heats, first law applied to systems and control volumes, steady and unsteady flow analysis.

Second Law of Thermodynamics: Kelvin-Planck and Clausius statements, reversible and irreversible processes, Carnot theorems, thermodynamic temperature scale, Clausius inequality and concept of entropy, principle of increase of entropy; availability and irreversibility.

Properties of Pure Substances: Thermodynamic properties of pure substances in solid, liquid and vapor phases, P-V-T behaviour of simple compressible substances, phase rule, thermodynamic property tables and charts, ideal and real gases, equations of state, compressibility chart.

Thermodynamic Relations: T-ds relations, Maxwell equations, Joule-Thomson coefficient, coefficient of volume expansion, adiabatic and isothermal compressibilities, Clapeyron equation.

Thermodynamic cycles: Carnot vapor power cycle, Ideal Rankine cycle, Rankine Reheat cycle, Air standard Otto cycle, Air standard Diesel cycle, Air-standard Brayton cycle, Vapor-compression refrigeration cycle.

Ideal Gas Mixtures: Dalton's and Amagat's laws, calculations of properties, air-water vapor mixtures and simple thermodynamic processes involving them.

SECTION F: POLYMER SCIENCE AND ENGINEERING

Chemistry of high polymers: Monomers, functionality, degree of polymerizations, classification of polymers, glass transition, melting transition, criteria for rubberiness, polymerization methods: addition and condensation; their kinetics, metallocene polymers and other newer techniques of polymerization, copolymerization, monomer reactivity ratios and its significance, kinetics, different copolymers, random, alternating, azeotropic copolymerization, block and graft copolymers, techniques for copolymerization-bulk, solution, suspension, emulsion.

Polymer Characterization: Solubility and swelling, concept of average molecular weight, determination of number average, weight average, viscosity average and Z-average molecular weights, polymer crystallinity, analysis of polymers using IR, XRD, thermal (DSC, DMTA, TGA), microscopic (optical and electronic) techniques.
Synthesis and properties: Commodity and general purpose thermoplastics: PE, PP, PS, PVC, Polyesters, Acrylic, PU polymers. Engineering Plastics: Nylon, PC, PBT, PSU, PPO, ABS, Fluoropolymers Thermosetting polymers: PF, MF, UF, Epoxy, Unsaturated polyester, Alkyds. Natural and synthetic rubbers: Recovery of NR hydrocarbon from latex, SBR, Nitrile, CR, CSM, EPDM, IIR, BR, Silicone, TPE.

Polymer blends and composites: Difference between blends and composites, their significance, choice of polymers for blending, blend miscibility-miscible and immiscible blends, thermodynamics, phase morphology, polymer alloys, polymer eutectics, plastic-plastic, rubber-plastic and rubber-rubber blends, FRP, particulate, long and short fibre reinforced composites.

Polymer Technology: Polymer compounding-need and significance, different compounding ingredients for rubber and plastics, crosslinking and vulcanization, vulcanization kinetics.

Polymer rheology: Flow of Newtonian and non-Newtonian fluids, different flow equations, dependence of shear modulus on temperature, molecular/segmental deformations at different zones and transitions. Measurements of rheological parameters by capillary rotating, parallel plate, cone-plate rheometer. viscoelasticity-creep and stress relaxations, mechanical models, control of rheological characteristics through compounding, rubber curing in parallel plate viscometer, ODR and MDR.

Polymer processing: Compression molding, transfer molding, injection molding, blow molding, reaction injection molding, extrusion, pultrusion, calendaring, rotational molding, thermoforming, rubber processing in two-roll mill, internal mixer.

Polymer testing: Mechanical-static and dynamic tensile, flexural, compressive, abrasion, endurance, fatigue, hardness, tear, resilience, impact, toughness. Conductivity-thermal and electrical, dielectric constant, dissipation factor, power factor, electric resistance, surface resistivity, volume resistivity, swelling, ageing resistance, environmental stress cracking resistance.

SECTION G: FOOD TECHNOLOGY

Food Chemistry and Nutrition: Carbohydrates: Structure and functional properties of mono- oligo-polysaccharides including starch, cellulose, pectic substances and dietary fibre; Proteins: Classification and structure of proteins in food; Lipids: Classification and structure of lipids, Rancidity of fats, Polymerization and polymorphism; Pigments: Carotenoids, chlorophylls, anthocyanins, tannins and myoglobin; Food flavours: Terpenes, esters, ketones and quinones; Enzymes: Specificity, Kinetics and inhibition, Coenzymes, Enzymatic and non-enzymatic browning; Nutrition: Balanced diet, Essential amino acids and fatty acids, PER, Water soluble and fat soluble vitamins, Role of minerals in nutrition, Antinutrients, Nutrition deficiency diseases.

Food Microbiology: Characteristics of microorganisms: Morphology, structure and detection of bacteria, yeast and mold in food, Spores and vegetative cells; Microbial growth in food: Intrinsic and extrinsic factors, Growth and death kinetics, serial dilution method for quantification; Food spoilage: Contributing factors, Spoilage bacteria, Microbial spoilage of milk and milk products, meat and meat products; Foodborne disease: Toxins produced by Staphylococcus, Clostridium and Aspergillus; Bacterial pathogens: Salmonella, Bacillus, Listeria, Escherichia coli, Shigella, Campylobacter; Fermented food: Buttermilk, yoghurt, cheese, sausage, alcoholic beverage, vinegar, sauerkraut and soya sauce.

Food Products Technology: Processing principles: Canning, chilling, freezing, dehydration, control of water activity, CA and MA storage, fermentation, hurdle technology, addition of preservatives and food additives, Food packaging, cleaning in place and food laws.; Grain products processing: Milling of rice, wheat, and maize, parboiling of paddy, production of bread, biscuits, extruded products and breakfast cereals, Solvent extraction, refining and hydrogenation of oil; Fruits, vegetables and plantation products processing: Extraction, clarification concentration and packaging of fruit juice, Production of jam, jelly, marmalade, squash, candies, and pickles, pectin from fruit waste, tea, coffee, chocolate and essential oils from spices; Milk and milk products processing: Pasteurized and sterilized milk, cream, butter, ghee, ice-cream, cheese and milk powder; Animal products processing: Drying and canning of fish, post mortem changes, tenderization and freezing of meat, egg powder.

Food Engineering: Mass and energy balance; Momentum transfer: Flow rate and pressure drop relationships for Newtonian fluids flowing through pipe, Characteristics of non-Newtonian fluids - generalized viscosity coefficient and Reynolds number, Flow of compressible fluid, Flow measurement, Pumps and compressors; Heat transfer: Heat transfer by conduction, convection, radiation, boiling and condensation, Unsteady state heat transfer in simple geometry, NTU-effectiveness relationship of co-current and counter current double pipe heat exchanger; Mass transfer: Molecular diffusion and Fick's Law, Steady state mass transfer, Convective mass transfer, Permeability of films and laminates; Mechanical operations: Energy requirement and rate of operations involved in size reduction of solids, high pressure homogenization, filtration, centrifugation, settling, sieving, flow through porous bed, agitation of liquid, solid-solid mixing, and single screw extrusion; Thermal operations: Energy requirement and rate of operations involved in process time evaluation in batch and continuous sterilization, evaporation of liquid foods, hot air drying of solids, spray and freeze-drying, freezing and crystallization; Mass transfer operations: Properties of air-water vapor mixture; Humidification and dehumidification operations.

21. Life Sciences – XL

SECTION H: CHEMISTRY (Compulsory)

Atomic structure and periodicity: Planck's quantum theory, wave particle duality, uncertainty principle, quantum mechanical model of hydrogen atom; electronic configuration of atoms; periodic table and periodic properties; ionization energy, election affinity, electronegativity, atomic size.

Structure and bonding: Ionic and covalent bonding, M.O. and V.B. approaches for diatomic molecules, VSEPR theory and shape of molecules, hybridisation, resonance, dipole moment, structure parameters such as bond length, bond angle and bond energy, hydrogen bonding, van der Waals interactions. Ionic solids, ionic radii, lattice energy (Born-Haber Cycle).

s.p. and d Block Elements: Oxides, halides and hydrides of alkali and alkaline earth metals, B, Al, Si, N, P, and S, general characteristics of 3d elements, coordination complexes: valence bond and crystal field theory, color, geometry and magnetic properties.

Chemical Equilibria: Colligative properties of solutions, ionic equilibria in solution, solubility product, common ion effect, hydrolysis of salts, pH, buffer and their applications in chemical analysis, equilibrium constants (K_c, K_p and K_x) for homogeneous reactions,

Electrochemistry: Conductance, Kohlrausch law, Half Cell potentials, emf, Nernst equation, galvanic cells, thermodynamic aspects and their applications.

Reaction Kinetics: Rate constant, order of reaction, molecularity, activation energy, zero, first and second order kinetics, catalysis and elementary enzyme reactions.

Thermodynamics: First law, reversible and irreversible processes, internal energy, enthalpy, Kirchoff's equation, heat of reaction, Hess law, heat of formation, Second law, entropy, free energy, and work function. Gibbs-Helmholtz equation, Clausius-Clapeyron equation, free energy change and equilibrium constant, Troutons rule, Third law of thermodynamics.

Basis of Organic Reactions Mechanism: Elementary treatment of SN1, SN2, E1 and E2 reactions, Hoffmann and Saytzeff rules, Addition reactions, Markonikoff rule and Kharash effect, Diels-Alder reaction, aromatic electrophilic substitution, orientation effect as exemplified by various functional groups. Identification of functional groups by chemical tests

Structure-Reactivity Correlations: Acids and bases, electronic and steric effects, optical and geometrical isomerism, tautomerism, conformers, concept of aromaticity

SECTION I: BIOCHEMISTRY

Organization of life. Importance of water. Cell structure and organelles. Structure and function of biomolecules: Amino acids, Carbohydrates, Lipids, Proteins and Nucleic acids. Biochemical separation techniques and characterization: ion exchange, size exclusion and affinity chromatography, electrophoresis, UV-visible, fluorescence and Mass spectrometry. Protein structure, folding and function: Myoglobin, Hemoglobin, Lysozyme, Ribonuclease A, Carboxypeptidase and Chymotrypsin. Enzyme kinetics including its regulation and inhibition, Vitamins and Coenzymes.

Metabolism and bioenergetics. Generation and utilization of ATP. Metabolic pathways and their regulation: glycolysis, TCA cycle, pentose phosphate pathway, oxidative phosphorylation, gluconeogenesis, glycogen and fatty acid metabolism. Metabolism of Nitrogen containing compounds: nitrogen fixation, amino acids and nucleotides. Photosynthesis: the Calvin cycle.

Biological membranes. Transport across membranes. Signal transduction; hormones and neurotransmitters.

DNA replication, transcription and translation. Biochemical regulation of gene expression. Recombinant DNA technology and applications: PCR, site directed mutagenesis and DNA-microarray.

Immune system. Active and passive immunity. Complement system. Antibody structure, function and diversity. Cells of the immune system: T, B and macrophages. T and B cell activation. Major histocompatibilty complex. T cell receptor. Immunological techniques: Immunodiffusion, immunoelectrophoresis, RIA and ELISA.

SECTION J: BOTANY

Plant Systematics: Systems of classification (non-phylogenetic vs. phylogenetic - outline), plant groups, molecular systematics.
Plant Anatomy: Plant cell structure, organization, organelles, cytoskeleton, cell wall and membranes; anatomy of root, stem and leaves, meristems, vascular system, their ontogeny, structure and functions, secondary growth in plants and stellar organization.
Morphogenesis & Development: Cell cycle, cell division, life cycle of an angiosperm, pollination, fertilization, embryogenesis, seed formation, seed storage proteins, seed dormancy and germination.
Concept of cellular totipotency, clonal propagation; organogenesis and somatic embryogenesis, artificial seed, somaclonal variation, secondary metabolism in plant cell culture, embryo culture, *in vitro* fertilization.

Physiology and Biochemistry: Plant water relations, transport of minerals and solutes, stress physiology, stomatal physiology, signal transduction, N_2 metabolism, photosynthesis, photorespiration; respiration, Flowering: photoperiodism and vernalization, biochemical mechanisms involved in flowering; molecular mechanism of senencensce and aging, biosynthesis, mechanism of action and physiological effects of plant growth regulators, structure and function of biomolecules, (proteins, carbohydrates, lipids, nucleic acid), enzyme kinetics.

Genetics: Principles of Mendelian inheritance, linkage, recombination, genetic mapping; extrachromosomal inheritance; prokaryotic and eukaryotic genome organization, regulation of gene expression, gene mutation and repair, chromosomal aberrations (numerical and structural), transposons.

Plant Breeding and Genetic Modification: Principles, methods – selection, hybridization, heterosis; male sterility, genetic maps and molecular markers, sporophytic and gametophytic self incompability, haploidy, triploidy, somatic cell hybridization, marker-assisted selection, gene transfer methods viz. direct and vector-mediated, plastid transformation, transgenic plants and their application in agriculture, molecular pharming, plantibodies.

Economic Botany: A general account of economically and medicinally important plants- cereals, pulses, plants yielding fibers, timber, sugar, beverages, oils, rubber, pigments, dyes, gums, drugs and narcotics. Economic importance of algae, fungi, lichen and bacteria.

Plant Pathology: Nature and classification of plant diseases**,** diseases of important crops caused by fungi, bacteria and viruses, and their control measures, mechanism(s) of pathogenesis and resistance, molecular detection of pathogens; plant-microbe beneficial interactions.

Ecology and Environment: Ecosystems – types, dynamics, degradation, ecological succession; food chains and energy flow; vegetation types of the world, pollution and global warming, speciation and extinction, conservation strategies, cryopreservation, phytoremediation.

SECTION K: MICROBIOLOGY

Historical Perspective: Discovery of microbial world; Landmark discoveries relevant to the field of microbiology; Controversy over spontaneous generation; Role of microorganisms in transformation of organic matter and in the causation of diseases.

Methods in Microbiology: Pure culture techniques; Theory and practice of sterilization; Principles of microbial nutrition; Enrichment culture techniques for isolation of microorganisms; Light-, phase contrast- and electron-microscopy.

Microbial Taxonomy and Diversity: Bacteria, Archea and their broad classification; Eukaryotic microbes: Yeasts, molds and protozoa; Viruses and their classification; Molecular approaches to microbial taxonomy.

Prokaryotic and Eukaryotic Cells: Structure and Function: Prokaryotic Cells: cell walls, cell membranes, mechanisms of solute transport across membranes, Flagella and Pili, Capsules, Cell inclusions like endospores and gas vesicles; Eukaryotic cell organelles: Endoplasmic reticulum, Golgi apparatus, mitochondria and chloroplasts.

Microbial Growth: Definition of growth; Growth curve; Mathematical expression of exponential growth phase; Measurement of growth and growth yields; Synchronous growth; Continuous culture; Effect of environmental factors on growth.

Control of Micro-organisms: Effect of physical and chemical agents; Evaluation of effectiveness of antimicrobial agents.

Microbial Metabolism: Energetics: redox reactions and electron carriers; An overview of metabolism; Glycolysis; Pentose-phosphate pathway; Entner-Doudoroff pathway; Glyoxalate pathway; The citric acid cycle; Fermentation; Aerobic and anaerobic respiration; Chemolithotrophy; Photosynthesis; Calvin cycle; Biosynthetic pathway for fatty acids synthesis; Common regulatory mechanisms in synthesis of amino acids; Regulation of major metabolic pathways.

Microbial Diseases and Host Pathogen Interaction: Normal microbiota; Classification of infectious diseases; Reservoirs of infection; Nosocomial infection; Emerging infectious diseases; Mechanism of microbial pathogenicity; Nonspecific defense of host; Antigens and antibodies; Humoral and cell mediated immunity; Vaccines; Immune deficiency; Human diseases caused by viruses, bacteria, and pathogenic fungi.

Chemotherapy/Antibiotics: General characteristics of antimicrobial drugs; Antibiotics: Classification, mode of action and resistance; Antifungal and antiviral drugs.

Microbial Genetics: Types of mutation; UV and chemical mutagens; Selection of mutants; Ames test for mutagenesis; Bacterial genetic system: transformation, conjugation, transduction, recombination, plasmids, transposons; DNA repair; Regulation of gene expression: repression and induction; Operon model; Bacterial genome with special reference to *E.coli;* Phage λ and its life cycle; RNA phages; RNA viruses; Retroviruses; Basic concept of microbial genomics.

Microbial Ecology: Microbial interactions; Carbon, sulphur and nitrogen cycles; Soil microorganisms associated with vascular plants.

SECTION L: ZOOLOGY

Animal world: Animal diversity, distribution, systematics and classification of animals, phylogenetic relationships.

Evolution: Origin and history of life on earth, theories of evolution, natural selection, adaptation, speciation.

Genetics: Principles of inheritance, molecular basis of heredity, mutations, cytoplasmic inheritance, linkage and mapping of genes.

Biochemistry and Molecular Biology: Nucleic acids, proteins, lipids and carbohydrates; replication, transcription and translation; regulation of gene expression, organization of genome, Kreb's cycle, glycolysis, enzyme catalysis, hormones and their actions, vitamins.

Cell Biology: Structure of cell, cellular organelles and their structure and function, cell cycle, cell division, chromosomes and chromatin structure. Eukaryotic gene organization and expression (Basic principles of signal transduction).

Animal Anatomy and Physiology: Comparative physiology, the respiratory system, circulatory system, digestive system, the nervous system, the excretory system, the endocrine system, the reproductive system, the skeletal system, osmoregulation.

Parasitology and Immunology: Nature of parasite, host-parasite relation, protozoan and helminthic parasites, the immune response, cellular and humoral immune response, evolution of the immune system.

Development Biology: Embryonic development, cellular differentiation, organogenesis, metamorphosis, genetic basis of development, stem cells.

Ecology: The ecosystem, habitats, the food chain, population dynamics, species diversity, zoogerography, biogeochemical cycles, conservation biology.

Animal Behaviour: Types of behaviours, courtship, mating and territoriality, instinct, learning and memory, social behaviour across the animal taxa, communication, pheromones, evolution of animal behaviour.

ANNEXURE – II: Codes for filling GATE Application Form

A. Codes for Examination Cities

IISc Bangalore Zone	
Ananthapur	101
Bagalkot	102
Bangalore	103
Davangere	104
Hassan	105
Hyderabad	106
Kurnool	107
Mahabubnagar	108
Mysore	109
Surathkal	110

IIT Bombay Zone	
Ahmednagar	201
Akola	202
Amravati	203
Aurangabad	204
Gulbarga	205
Hubli	206
Jalgaon	207
Kolhapur	208
Loni	209
Mumbai	210
Nagpur	211
Nanded	212
Nasik	213
Navi Mumbai	214
Pandharpur	215
Pune	216
Sangli	217
Satara	218
Shegaon	219
Solapur	220
Thane	221
Wardha	222
Goa	223

IIT Delhi Zone	
Ahmedabad	301
Ajmer	302
Alwar	303
Bikaner	304
Chandigarh	305
Dausa	306
Faridabad	307
Gurgaon	308
Jaipur	309
Jalandhar	310
Jammu	311
Jodhpur	312
Ludhiana	313
Mahesana	314
New Delhi	315
Patiala	316
Rajkot	317
Sikar	318
Surat	319
Udaipur	320
Vadodara	321

IIT Guwahati Zone	
Agartala	401
Asansol	402
Bhagalpur	403
Dhanbad	404
Durgapur	405
Gangtok	406
Guwahati	407
Imphal	408
Itanagar	409
Jorhat	410
Kalyani	411
Patna	412
Silchar	413
Siliguri	414
Tezpur	415

IIT Kanpur Zone	
Allahabad	501
Bhopal	502
Gorakhpur	503
Indore	504
Jabalpur	505
Jhansi	506
Kanpur	507
Lucknow	508
Saugar (Sagar, MP)	509
Sultanpur	510
Ujjain	511
Varanasi	512

IIT Kharagpur Zone	
Balasore	601
Berhampur (Orissa)	602
Bhimavaram	603
Bhubaneswar	604
Bilaspur	605
Cuttack	606
Eluru	607
Jamshedpur	608
Kakinada (AP)	609
Kharagpur	610
Kolkata	611
Machilipatnam	612
Raipur	613
Rajahmundry	614
Ranchi	615
Rourkela	616
Sambalpur	617
Tadepalligudem	618
Vijayawada	619
Visakhapatnam	620

IIT Madras Zone	
Bapatla	701
Chittoor	702
Kadapa (Cuddapah)	703
Gudur	704
Guntur	705
Karimnagar	706
Khammam	707
Kothagudem	708
Manchiryal	709
Nalgonda	710
Nellore	711
Ongole	712
Tenali	713
Tirupati	714
Warangal	715
Ernakulam	716
Kannur	717
Kollam	718
Kottayam	719
Kozhikode	720
Palakkad	721
Thiruvananthapuram	722
Thrissur	723
Chennai	724
Chidambaram	725
Coimbatore	726
Dindigul	727
Madurai	728
Nagercoil	729
Salem	730
Thanjavur	731
Tiruchirapalli	732
Tirunelveli	733
Puducherry	734

IIT Roorkee Zone	
Agra	801
Aligarh	802
Amritsar	803
Bathinda	804
Bareilly	805
Bijnor	806
Dehradun	807
Ghaziabad	808
Gwalior	809
Hamirpur (HP)	810
Haridwar	811
Hissar	812
Kota	813
Kurukshetra	814
Mathura	815
Meerut	816
Muzaffarnagar	817
Noida	818
Pantnagar	819
Rohtak	820
Roorkee	821
Shimla	822
Yamunanagar	823

B. Codes for Qualifying Disciplines

Discipline	Code
Engineering/Technology:	
Aerospace Engg.	01
Aeronautical Engg.	02
Agricultural Engg.	03
Applied Mechanics	04
Architecture	05
Automobile Engg.	06
Biochemical Engg.	07
Biomedical Engg.	08
Biotechnology	09
Ceramic & Glass Technology	10
Chemical Engg.	11
Chemical Technology	12
Civil/Civil & Environmental/Structural Engg./ Consturction Engg.	13
Computer Science & Engg./Technology	14
Control and Instrumentation	15
Electrical Engg.	16
Electro-Chemical Engg.	17
Electronics & Comm./Electronics Engg./Comm. Engg./Telecommunication Engg.	18
Energy Engg.	19
Environmental Engg.	20
Food Technology/Food Processing Engg.	21
Industrial Engg.	22
Industrial Management	23
Information Technology	24
Instrumentation/ Electronics/Control	25
Instrumentation & Process Control	26
Manufacturing Engg.	27
Material Scinece and Engineering	28
Mechanical Engg.	29
Mechatronics	30
Medical Instrumentation	31
Metallurgical Engg./ Industrial Metallurgy	32
Mineral Engg./Mineral Dressing	33
Mining Engg./Technology, Mining & Machinery	34
Naval Architecture/Marine Engg.	35
Oil Technology	36
Paint Technology	37
Petro-Chemical Engg.	38
Petroleum Engg./Technology	39

Discipline	Code
Engineering/Technology:	
Planning	40
Plastic Technology	41
Polymer Technology/Science	42
Production Engg./Production & Management	43
Production & Industrial Engg.	44
Rubber Technology	45
Renewable Energy	46
Textile Engineering & Fibre Science	47
All other disciplines in Engg./Technology	48

Discipline	Code
Sciences:	
Applied Electronics	61
Applied Physics	62
Agricultural Science	63
Biochemistry	64
Bio-Sciences	65
Computer Applications	66
Chemistry	67
Industrial Chemistry	68
Electronics	69
Engineering Physics	70
Earth Sciences	71
Geology/ Geophysics	72
Life Sciences	73
Life Science/Veterinary/Animal Science	74
Life Sciences (Botany)	75
Life Sciences (Zoology)	76
Materials Science	77
Mathematics/Applied Mathematics	78
Microbiology	79
Nano Science & Technology	80
Nuclear Physics	81
Operations Research	82
Physics	83
Pharmaceutical Sciences/Pharmacy	84
Radio Physics	85
Radio Physics & Electronics	86
Statistics	87
Textile Chemistry	88
All other disciplines in Sciences	89

C. Codes for States/ Union Territories of Permanent Residence

States/Union Territories	Code
Andaman & Nicobar	AN
Andhra Pradesh	AP
Arunachal Pradesh	AR
Assam	AS
Bihar	BR
Chattisgarh	CG
Chandigarh	CH
Daman & Diu	DD
Dadra and Nagar Haveli	DH
Delhi	DL
Goa	GA
Gujarat	GJ
Himachal Pradesh	HP
Haryana	HR
Jharkhand	JD
Jammu & Kashmir	JK
Karnataka	KA
Kerala	KL
Lakshadweep	LD
Meghalaya	MA
Maharashtra	MH
Manipur	MN
Madhya Pradesh	MP
Mizoram	MZ
Nagaland	NL
Orissa	OR
Punjab	PB
Puducherry (Pondicherry)	PY
Rajasthan	RJ
Sikkim	SM
Tripura	TA
Tamil Nadu	TN
Uttarakhand	UK
Uttar Pradesh	UP
West Bengal	WB
Others	OT

Examination cities	Address to which completed Application Form is to be sent	Telephone, Fax and E-mail
Zone 1 Ananthapur, Bagalkot, Bangalore, Davangere, Hassan, Hyderabad, Kurnool, Mahabubnagar, Mysore and Surathkal	Chairman, GATE IISc Bangalore Bangalore - 560 012	Phone: 080-22932392 Fax: 080-23601227 E-mail: gate@gate.iisc.ernet.in
Zone 2 Ahmednagar, Akola, Amravati, Aurangabad, Gulbarga, Hubli, Jalgaon, Kolhapur, Loni, Mumbai, Nagpur, Nanded, Nasik, Navi Mumbai, Pandharpur, Pune, Sangli, Satara, Shegaon, Solapur, Thane, Wardha and Goa	Chairman, GATE IIT Bombay Powai, Mumbai - 400 076	Phone: 022-25767068 Fax: 022-25723706 E-mail: gateoffice@iitb.ac.in
Zone 3 Ahmedabad, Ajmer, Alwar, Bikaner, Chandigarh, Dausa, Faridabad, Gurgaon, Jaipur, Jalandhar, Jammu, Jodhpur, Ludhiana, Mahesana, New Delhi, Patiala, Rajkot, Sikar, Surat, Udaipur and Vadodara	Chairman, GATE IIT Delhi Hauz Khas, New Delhi – 110016	Phone: 011-26591749 Fax: 011-26581579 E-mail: gate@admin.iitd.ernet.in
Zone 4 Agartala, Asansol, Bhagalpur, Dhanbad, Durgapur, Gangtok, Guwahati, Imphal, Itanagar, Jorhat, Kalyani, Patna, Silchar, Siliguri and Tezpur	Chairman, GATE IIT Guwahati Guwahati – 781039	Phone: 0361-2582751 Fax: 0361-2582755 E-mail: gate@iitg.ernet.in
Zone 5 Allahabad, Bhopal, Gorakhpur, Indore, Jabalpur, Jhansi, Kanpur, Lucknow, Saugar (Sagar, MP), Sultanpur, Ujjain and Varanasi	Chairman, GATE IIT Kanpur Kanpur – 208016	Phone: 0512-2597412 Fax: 0512-2590932 E-mail: gate@iitk.ac.in
Zone 6 Balasore, Berhampur (Orissa), Bhimavaram, Bhubaneswar, Bilaspur, Cuttack, Eluru, Jamshedpur, Kakinada (AP), Kharagpur, Kolkata, Machilipatnam, Raipur, Rajahmundry, Ranchi, Rourkela, Sambalpur, Tadepalligudem, Vijayawada and Visakhapatnam	Chairman, GATE IIT Kharagpur Kharagpur - 721302	Phone: 03222-282091 Fax: 03222-278243 E-mail: gate@adm.iitkgp.ernet.in
Zone 7 Bapatla, Chennai, Chidambaram, Chittoor, Coimbatore, Dindigul, Ernakulam, Gudur, Guntur, Kadapa (Cuddapah), Kannur, Karimnagar, Khammam, Kollam, Kothagudem, Kottayam, Kozhikode, Madurai, Manchiryal, Nagercoil, Nalgonda, Nellore, Ongole, Palakkad, Puducherry (Pondicherry), Salem, Tenali, Thanjavur, Thiruvananthapuram, Thrissur, Tiruchirapalli, Tirunelveli, Tirupati and Warangal	Chairman, GATE IIT Madras Chennai – 600036	Phone: 044-22578200 Fax: 044-22578204 E-mail: gate@iitm.ac.in
Zone 8 Agra, Aligarh, Amritsar, Bathinda, Bareilly, Bijnor, Dehradun, Ghaziabad, Gwalior, Hamirpur (HP), Haridwar, Hissar, Kota, Kurukshetra, Mathura, Meerut, Muzaffarnagar, Noida, Pantnagar, Rohtak, Roorkee, Shimla and Yamunanagar	Chairman, GATE IIT Roorkee Roorkee – 247667	Phone: 01332-284531 Fax : 01332-285707 E-mail: gate@iitr.ernet.in

Check List for Submission of Application Form

1. Filled in Application Form
2. Original Bank Pay-in-Slip / Receipt from GATE Office
3. Attested copy of SC/ST Certificate (if applicable)
4. Attested copy of PD Certificate (if applicable)
5. In case of PD candidates, requested for an Amanuensis (if applicable)
6. Attested copy of the Affidavit for Change of Name/Surname (if applicable)
7. Duly completed and stamped Acknowledgement Card
8. Place the above documents in the given envelope

GATE2010

IMPORTANT DATES

Last date for issue of Information Brochure and Application Form		
1. by post from GATE Offices	Tuesday	Oct 20, 2009
2. at bank counters	Wednesday	Oct 28, 2009
3. at GATE office counters	Friday	Oct 30, 2009
Last date for		
1. Submission of Online Application Form (website closure)	Wednesday	Oct 28, 2009 (18.00 hrs)
2. Receipt of completed Offline/Online Application Form at the respective zonal GATE Office	Tuesday	Nov 03, 2009

Date and Time of Examination

Computer based ONLINE GATE Examination

Textile Engineering and Fibre Science (TF) Paper
February 07, 2010 (Sunday)
09:30 hrs - 12:30 hrs

Mining Engineering (MN) Paper
February 07, 2010 (Sunday)
14:30 hrs - 17:30 hrs

OFFLINE GATE Examination in all other papers

February 14, 2010 (Sunday)
09:30 hrs - 12:30 hrs

Announcement of Results

March 15, 2010 (Monday)