

GATE 2013

Graduate Aptitude Test in Engineering Information Brochure



Organizing Institute
Indian Institute of Technology Bombay

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1 Introduction

Graduate Aptitude Test in Engineering (GATE) is an all India examination that primarily tests a comprehensive understanding of various undergraduate subjects in Engineering and Technology. The GATE score of a candidate reflects a relative performance level in a particular paper in the exam across several years. The score is used for admissions to post-graduate engineering programmes (eg. M.E., M.Tech, direct Ph.D.) in Indian higher education institutes with financial assistance provided by MHRD and other Government agencies. The score may also be used by Public sector units for employment screening purposes.

1.1 Financial Assistance

A valid GATE score is essential for obtaining a financial assistance during Masters programmes and direct Doctoral programmes in Engineering/Technology/Architecture, and Doctoral programs in relevant branches of Science in an Institution supported by the MHRD or other Government assistantships. As per the directives of the MHRD, the following procedure is to be adopted for admission to the postgraduate programmes (Master and Doctoral) with MHRD scholarship/assistantship. The performance of the candidate in GATE will be considered for admission. If the candidate is to be selected through interview for postgraduate programmes, minimum 70% weightage is to be given to the performance in GATE. The remaining weightage (30% maximum) may be given to the candidate's academic record or performance in interview. The admitting institution could however 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.

To avail the financial assistance (scholarship), the candidate must first secure admission to a programme in these Institutes, by a procedure that could be different for each institute.

Qualification in GATE is also a minimum requirement to apply for various fellowships awarded by many Government organizations. Candidates are advised to seek details of admission procedures and availability of MHRD scholarship/assistantship from the concerned admitting institution. The criteria for postgraduate admission with scholarship/assistantship are different for different admitting institutions. The management of the postgraduate scholarship/assistantship is also the responsibility of the admitting institution. Similarly, reservation of seats under different categories is as per the policies and norms prevailing at the admitting institution and Government of India rules. GATE offices will not entertain any enquiry about admission, reservation of seats or award of scholarship/assistantship

Nevertheless, candidates with Master's degree in Engineering/Technology/Architecture may seek admission to relevant Doctoral programmes with scholarship/assistantship without appearing in the GATE examination.

1.2 Administration

GATE is administered and conducted jointly by the Indian Institute of Science and seven Indian Institutes of Technology on behalf of the National Coordination Board (NCB) – 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.

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 2013 lies with **Indian Institute of Technology Bombay**, and is designated as the **Organizing Institute** for GATE 2013.

Organization of the Brochure

The information in this brochure is mainly categorized into **Pre-Exam** (Eligibility, Application submission, Exam Centers etc.), **Examination** (Syllabus, Pattern, Scoring, Model Question Papers etc.) & **Post-Exam** (Answers, Results, Score Card etc.) sections.

2 What's New in GATE 2013?

1. 15 subject papers will be conducted by an ONLINE computer based test: AE, AG, AR, BT, CE, CH, CY, GG, MA, MN, MT, PH, TF, XE, and XL.
2. Female candidates are exempted from paying the application fee, as required by MHRD, Govt. of India.
3. All candidate related information and grievance redressal will be available in a single GATE Online Applicant Interface.
4. Soft copies of photograph and signature must be uploaded during online application (This is in addition to sending recent photograph of applicant with signed application).
5. A new formula will be used for calculating the GATE score.
6. Biometric information (Photograph and fingerprint) maybe captured on the day of the examination for randomly selected candidates.

2.1 Other Important points about GATE 2013

- 1 Application Process: For GATE 2013, candidates need to register and fill the application ONLINE only by accessing the zonal GATE websites of IISc and seven IITs. The application process is complete only when a print out of the filled ONLINE application with the candidate's signature and a good quality photo affixed in the appropriate place is received by the respective GATE office along with necessary documents, if any, on or before 8 October 2012. Please note that application forms are NOT available for sale anywhere.
- 2 Downloadable Admit Card: Admit cards are NOT sent by mail anymore. Admit cards can only be downloaded from the zonal GATE websites from 5th December 2012 onwards. Bring the admit card to the test center along with at least one original (not photocopied / scanned copy) and valid (not expired) photo identification.
- 3 Use of black ink ballpoint pen for Offline exams: Candidates should use only **black ink ballpoint pen** for darkening of the bubbles in the OMR sheet. Since bubbles darkened by the black ink ballpoint pen cannot be erased, candidates should darken the bubbles in the OMR sheet very carefully.
- 4 Numerical answer type questions in ONLINE papers: In the ONLINE papers, the question paper will consist of questions of multiple-choice type and questions of numerical answer type. For multiple choice type questions, each question will have four choices for the answer. For numerical answer type questions, each question will have a number as the answer. Each online paper will have 15 or more marks worth of questions requiring numerical answers where possible.
- 5 Pre-final year students: Pre-final year students are **NOT eligible** to write GATE 2013. For details, refer to Section 4.1 eligibility for GATE examination.

2.2 Important Dates related to GATE 2013

GATE Online Applicant Interface (website) Opens	Saturday	1 September 2012 (00:00 Hrs)
Last date for Submission of Online Application (website closure)	Sunday	30 September 2012 (23:00 Hrs)
Last date for the receipt of printed version of ONLINE Application at the respective zonal GATE Office	Monday	8 October 2012
Last date for request of change of city	Tuesday	20 November 2012
Availability of admit card on Online Application Interface	Wednesday	5 December, 2012
GATE 2013 Online Examination for Papers: AR, CE, GG, MA, MT, PH and TF*	Sunday	20 January 2013 (09:00 Hrs to 12:00 Hrs)
GATE 2013 Online Examination Papers: AE, AG, BT, CH, CY, MN, XE and XL*	Sunday	20 January 2013 (14:00 Hrs to 17:00 Hrs)
GATE 2013 Offline Examination Papers: CS, ME and PI*	Sunday	10 February 2013 (09:00 Hrs to 12:00 Hrs)
GATE 2013 Offline Examination Papers: EC, EE and IN*	Sunday	10 February 2013 (14:00 Hrs to 17:00 Hrs)
Announcement of results on Online Applicant Interface	Friday	15 March 2013 (10:00 Hrs)

* Please see Section 3.2 for a complete list of GATE papers and their codes.

3 Pre Exam Related Information

Note to the Candidates: *Before* you start the application process, you must:

1. Ensure you are eligible for GATE 2013 (See Section 3.1)
2. Determine the GATE paper you wish to appear for (You can appear in only one paper for GATE 2013).
3. Choose at least two cities from the table of Cities given this Brochure that are convenient for you to write the exam. (See Section 3.4)

In addition, please note that:

1. The Application for appearing in GATE 2013 must be made online only.
2. Your choice of exam paper will determine the examination type (online/offline), date, and choice of available cities.

3.1 Eligibility for GATE

Only the following categories of candidates are eligible to appear for GATE 2013. Necessary supporting documents must be submitted ONLINE or by post during the submission of the application form for the exam. Please read this carefully and make sure that your year of qualification is not later than what is specified below.

Qualifying Degree (Short)	Qualifying Degree/Examination (Descriptive)	Description of Eligible Candidates	Year of qualification cannot be later than	Copies of Certificates to be submitted	
				Passed in the year 2012 or earlier	Expected to complete in 2013 or later
B.E./B.Tech/B.Arch	Bachelor's degree in Engineering/Technology/Architecture (4 years after 10+2/Post B.Sc./Post-Diploma)	4th year or Completed	2013	Degree Certificate / Provisional Certificate / Course Completion Certificate	Certificate from Principal
MSc./M.A./MCA equivalent	Master's degree in any branch of Science / Mathematics / Statistics / Computer Applications or equivalent	Final year or Completed	2013	Degree Certificate / Provisional Certificate / Course Completion Certificate (pertaining to Masters degree)	Certificate from Principal
Int. M.E./M.Tech or DD (after 10+2 or Diploma)	Integrated Master's degree programs or Dual Degree programs in Engineering / Technology (Five year programme)	4th/5th Year or Completed	2014	Degree Certificate / Provisional Certificate / Course Completion Certificate	Certificate from Principal
Int. M.E./M.Tech (Post BSc)	Post-BSc Integrated Master's degree programs in Engineering / Technology (Four year programme)	2nd/3rd/4th year or Completed	2015	Degree Certificate / Provisional Certificate / Course Completion Certificate	Certificate from Principal
Professional Society Examinations (equivalent to B.E./B.Tech/B.Arch)	B.E./B.Tech equivalent examinations, of Professional Societies, recognized by MHRD/UPSC/AICTE (e.g. AMIE by Institution of Engineers-India, AMICE by the Institute of Civil Engineers-India)	Completed section A or equivalent of such professional courses	NA	Professional Certificate/ Provisional Certificate/ Course Completion/ Membership Certificate issued by the Society or Institute	Copy of Marksheet for Section "A"

Certificate from Principal

Candidates who have to submit a certificate from their Principal, as determined from the above table, have to obtain a signature from their principal on a certificate that will be printed on the application PDF file provided after completion of online application submission.

Candidates with backlogs

Candidates who have appeared in the final semester/year exam in 2012, but with a backlog (arrears/failed subjects) in any of the papers in their qualifying degree should submit

1. A copy of any one of the marks sheets of the final year, OR

2. A letter from the principal indicating that the student has a backlog from an earlier semester/year to be cleared, and therefore cannot produce a course completion certificate now. This certificate will also be present in the last portion of the PDF application form provided to you after you submit application online.

3.2 GATE Papers

GATE 2013 will be conducted in the following subjects (also referred to as “papers”). Candidates must familiarize with the paper code for the paper of their choice, as this knowledge will be required at the time of application form submission and appearing for the examination.

GATE Paper	Code	GATE 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		
*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	M
Food Technology	G		

3.3 Examination Schedule

GATE Paper Codes	Examination Time	Examination Date (Day)	Examination Type
AR, CE, GG, MA, MT, PH, and TF	09:00 hrs–12:00 hrs	20 January 2013 (Sunday)	ONLINE
AE, AG, BT, CH, CY, MN, XE and XL	14:00 hrs–17:00 hrs		
CS, ME and PI	09:00 hrs–12:00 hrs	10 February 2013 (Sunday)	OFFLINE
EC, EE and IN	14:00 hrs–17:00 hrs		

ONLINE Examination: A computer based test (CBT) where the candidate will use a computer mouse to choose a correct answer or enter a numerical answer via a virtual keypad.

OFFLINE Examination: A paper based examination where the candidate will mark the correct answer out of four options in an Optical Response Sheet (ORS) by darkening the appropriate bubble with a pen.

3.4 State-wise Exam Cities

The centers for online exam papers are **different** from the centers for offline exam papers. Please consult the table below. First determine if the paper of your choice is to be conducted online or offline, and check for a city in the state of your choice. Also seen in the table is the Zonal Administration Institute Office (Either of the IITs or IISc). This Zonal office will be your point of contact for any enquiries regarding your exam center.¹

State	Exam Mode	City	Zonal GATE Office
Andhra Pradesh	Online	Ananthapur, Hyderabad, Kurnool, Secunderabad	IISc
		Kakinada, Vijayawada, Visakhapatnam	IITKGP
		Bapatla, Guntur, Kadapa, Nellore, Tirupati, Warangal	IITM
	Offline	Ananthapur, Hyderabad, Kurnool, Mahabubnagar, Secunderabad	IISc
		Bhimavaram, Eluru, Kakinada, Machilipatnam, Rajahmundry, Srikakulam, Tadepalligudem, Vijayawada, Visakhapatnam	IITKGP
		Bapatla, Chittoor, Gudur, Guntur, Kadapa, Karimnagar, Khammam, Kothagudem, Manchiryal, Nalgonda, Nellore, Ongole, Tenali, Tirupati, Warangal	IITM
Arunachal Pradesh	Online	---	
	Offline	Itanagar	IITG
Assam	Online	Guwahati, Jorhat, Silchar, Tezpur	IITG
	Offline	Guwahati, Jorhat, Silchar, Tezpur	IITG
Bihar	Online	Patna	IITG
	Offline	Bhagalpur, Patna	IITG
Chattisgarh	Online	Bilaspur, Raipur	IITKGP
	Offline	Bilaspur, Raipur	IITKGP
Delhi	Online	Delhi	IITD
	Offline	Delhi Central, Delhi East, Delhi North, Delhi South, Delhi West	IITD
Goa	Online	---	
	Offline	Goa	IITB
Gujarat	Online	Ahmedabad, Rajkot, Surat, Vadodara	IITB

¹ While we will make every effort to allocate you to a center in the city of your choice, please note that centers may be added or removed at the discretion of the GATE committee. In case a center in the city of your choice is not available, we will allot a center that is geographically closest to the city of your choice.

State	Exam Mode	City	Zonal GATE Office
	Offline	Ahmedabad, Mahesana, Rajkot, Surat, Vadodara	IITB
Haryana	Online	Faridabad, Gurgaon	IITD
		Hisar, Kurukshetra, Rohtak	IITR
	Offline	Faridabad, Gurgaon	IITD
		Hisar, Kurukshetra, Rohtak, Yamunanagar	IITR
Himachal Pradesh	Online	Hamirpur, Shimla	IITR
	Offline	Hamirpur, Shimla	IITR
Jammu & Kashmir	Online	Jammu	IITR
	Offline	Jammu	IITR
Jharkhand	Online	Dhanbad	IITG
		Jamshedpur, Ranchi	IITKGP
	Offline	Dhanbad	IITG
		Jamshedpur, Ranchi	IITKGP
Karnataka	Online	Belgaum, Bengaluru, Davangere, Hassan, Hubli, Mangalore, Manipal, Mysore, Surathkal	IISc
		Gulbarga	IITB
	Offline	Bagalkot, Belgaum, Bengaluru, Davangere, Hassan, Hubli, Mangalore, Manipal, Mysore, Surathkal	IISc
		Gulbarga	IITB
Kerala	Online	Kanjirappally, Kannur, Kollam, Kottayam, Kozhikode, Palakkad, Thrissur	IISc
		Ernakulam, Thiruvananthapuram	IITM
	Offline	Alappuzha (Aleppy), Chengannur, Kanjirappally, Kannur, Kollam, Kothamangalam, Kottayam, Kozhikode, Palakkad, Thrissur	IISc
		Ernakulam, Thiruvananthapuram,	IITM
Madhya Pradesh	Online	Indore, Ujjain	IITD
		Bhopal, Gwalior, Jabalpur	IITK
	Offline	Indore, Ujjain	IITD
		Bhopal, Gwalior, Jabalpur, Saugar (Sagar, MP)	IITK
Maharashtra	Online	Ahmednagar, Amravati, Aurangabad, Jalgaon, Kolhapur, Mumbai (Central Line), Mumbai (Western Line), Nagpur, Nanded, Nashik, Navi Mumbai, Pune (City), Pune (Pimpri Chinchwad), Sangli, Solapur, Thane	IITB
	Offline	Ahmednagar, Akola, Amravati, Aurangabad, Bhusawal, Gondia, Jalgaon, Kolhapur, Latur, Lonavala, Loni, Mumbai (Central Line), Mumbai (Western Line), Nagpur, Nanded, Nashik, Navi Mumbai, Pandharpur, Pune (City), Pune	IITB

State	Exam Mode	City	Zonal GATE Office
		(Pimpri Chinchwad), Sangli, Satara, Shegaon, Solapur, Thane, Wardha	
Manipur	Online	Imphal	IITG
	Offline	Imphal	IITG
Orissa	Online	Bhubaneswar, Cuttack, Rourkela, Sambalpur	IITKGP
	Offline	Balasore, Berhampur, Bhubaneswar, Cuttack, Rourkela, Sambalpur	IITKGP
Puducherry	Online	Puducherry	IITM
	Offline	Puducherry	IITM
Punjab	Online	Amritsar, Bathinda, Chandigarh, Jalandhar, Patiala	IITR
	Offline	Amritsar, Bathinda, Chandigarh, Jalandhar, Ludhiana, Patiala	IITR
Rajasthan	Online	Ajmer, Bikaner, Jaipur, Jodhpur, Kota, Udaipur	IITD
	Offline	Ajmer, Alwar, Bikaner, Jaipur, Jodhpur, Kota, Sikar, Udaipur	IITD
Sikkim	Online	---	
	Offline	Gangtok	IITG
Tamil Nadu	Online	Chennai, Chidambaram, Coimbatore, Madurai, Salem, Thanjavur, Tiruchirapalli, Tirunelveli, Vellore	IITM
	Offline	Chennai North, Chennai South, Chidambaram, Coimbatore, Dindigul, Madurai, Nagercoil, Salem, Thanjavur, Tiruchirapalli, Tirunelveli, Vellore	IITM
Tripura	Online	Agartala	IITG
	Offline	Agartala	IITG
Uttar Pradesh	Online	Agra, Aligarh, Allahabad, Bareilly, Kanpur, Lucknow, Varanasi	IITK
		Ghaziabad, Meerut, Muzaffarnagar, Noida	IITR
	Offline	Mathura	IITD
		Agra, Aligarh, Allahabad, Bareilly, Gorakhpur, Jhansi, Kanpur, Lucknow, Sultanpur, Varanasi	IITK
		Bijnor, Ghaziabad, Meerut, Muzaffarnagar, Noida	IITR
Uttarakhand	Online	Dehradun, Haldwani, Roorkee	IITR
	Offline	Dehradun, Haldwani, Haridwar, Roorkee, Srinagar	IITR
West Bengal	Online	Asansol, Durgapur, Kalyani, Siliguri	IITG
		Kharagpur, Greater Kolkata (North), Greater Kolkata (South)	IITKGP
	Offline	Asansol, Durgapur, Kalyani, Siliguri	IITG
		Kharagpur, Kolkata	IITKGP

3.5 How to Apply

All candidates **have to apply ONLINE**. Details of the application fee and the steps in the application process are given below. The application fee is non-refundable.

Category	Application Fee
General/OBC-NC (Male Candidates)	₹1200/-
SC / ST / PD* (Male Candidates)	₹ 600/-
Female Candidates	₹ 0 (Exempted)

* PD: Person with a Physical Disability

3.5.1 GATE Online Applicant Interface

An online interface is provided for most of your interaction with the GATE office. This interface can be accessed using url: <http://gateapp.iitb.ac.in> With this interface you can

1. Apply for the examination online
2. Upload photograph, signature, and supporting documents.
3. Make application fee payment through netbanking.
4. Check the status of your application form: Received, Under Scrutiny, Rejected after Scrutiny failed, Accepted after Successful Scrutiny, Admit Card Ready for Download, etc.
5. Contact the GATE office in case of any queries/problems (Grievance Redressal).
6. Download Admit Card.
7. View your answers, marks and GATE score.

The login to this interface is through your chosen email address and a password. Keep this information safe and do not disclose the email id and password to anyone.

3.5.2 Filling in Application Online

1. GATE Online Application Interface (website) can be accessed from the GATE website.
2. You must first register yourself, by providing a valid email address. Choose this carefully to be the one you check frequently, as all communications to you from the GATE offices will be sent to this address (DO NOT USE ANYBODY ELSE'S EMAIL ADDRESS. ONLY ONE PERSON CAN REGISTER WITH ONE EMAIL ADDRESS).
3. Upon registration, an email will be sent with a link and an one time password (OTP). You must click on the link and enter the password. You will be required to change the password after the first login. Choose a password that is not easily guessable (should not be like: your name, DOB, 12345, asdf, etc.), so as to ensure that the data you provide is not accessible to any person other than yourself.
4. Next you will see an application form to be filled in. Keep the following information ready:
 1. Personal information
 2. Communication Address (Important: PIN Code)
 3. Eligibility Degree Details (College address, PIN Code of College)
 4. GATE paper, Choice of GATE examination cities (See Section 3.2 and 3.4)
 5. High quality image of your photograph conforming to the requirements (see Section 3.5.5 for details on the quality of the photograph and signature)
 6. Good quality image of your signature (in .jpeg format) conforming to requirements similar to photograph
 7. Optional: PDF files of supporting documents (Eligibility & Category Certificates) (max file size: per file 0.5 MB See section 3.5.2.1). Please see Section 3.1 for the Eligibility Criteria and documents).
 8. Optional: Your Netbanking details to make the application fee payment (only for Male candidates).
5. Fill in the necessary data in the online application form following instructions given there. Upload the soft copies of photo and signature (mandatory).
6. Optional: You may upload pdf files of supporting documents conforming to the eligibility (except principal's certificate) and category requirements given below in section Supporting Documents
7. You will have to select one of the payment options (details given in Section 3.5.3) while filling the online form.
8. The GATE Online Applicant Interface allows you to enter data, "Save" partially filled form, "Logout", and resume filling in by logging in again.
9. Before you make the payment, you will be shown a "Preview" of your application, where you have to carefully check for any errors.
10. Once you submit the application with payment, no further changes to the application can be made by the candidate.

11. Candidates who have selected online payment option will follow the instructions given below for online net banking in payment section and complete payment process. Those who have selected challan payment option will directly proceed to the next step.
12. You will then see a link to “Print Application Form”. You have to download a PDF file from this link and print it. It will contain four pages as mentioned below
 1. Page 1: Instructions and Address slip where you need to send hard copy
 2. Page 2-3: Two copies of application form with bottom part showing certificate to be signed by principal (if need be)
 3. Page 4: Optional page for candidates who select “bank challan” mode of payment. This page will contain 3 copies of challan to be processed with bank

3.5.2.1 Supporting Documents

Applicants have an option to upload supporting documents online. Please make sure that the max file size permitted to upload per file is 0.5 MB. For scanning the documents please use the following setting

1. Resolution: 200 dpi
2. Color mode: 256 colors
3. File format: PDF or JPEG

3.5.2.1.1 Eligibility Documents

Eligibility criteria and necessary supporting documents can be found from the Eligibility table for GATE as given in Section 3.1.

3.5.2.1.2 SC/ST/PD Certificate

Only male applicants who claim to be in any of the category SC/ST/PD have to produce valid documentary evidence (details given in Section 8.1), to qualify for the reduced fee. applicants need not provide any SC/ST certificate, as the fee is exempted, as required by MHRD, Govt. of India..

However, if any female applicant requests a scribe to assist writing the exam, a PD certificate has to be provided.

Candidates who claim to be in any of the above categories have to submit photocopies of valid documents along with the application for evidence. Sources of valid evidence are given in Appendix A.

3.5.3 Application Fee Payment Options

Non-refundable application fee is charged only for male candidates. candidates are exempted from the payment of application fee, as required by MHRD, Govt. of India. All charges given below are in Indian Rupees.

Candidate Category	Mode	Application Fee	Bank Charges	Total to be Paid
Male General/OBC-NC	Online Netbanking	1200	10	1210
	Canara Bank Challan	1200	20	1220
	SBI Challan	1200	25	1225
Male SC/ST/PD	Online Netbanking	600	10	610
	Canara Bank Challan	600	20	620
	SBI Challan	600	25	625
Female	No Application Fee, as required by MHRD, Govt. of India.			

3.5.3.1 Online Net banking Payment Details

1. From the GATE Online Application Interface, you will be redirected to a bank you choose.
2. You will have to login with your bank's Net banking (or Internet Banking) user ID and password.
3. The fee amount and bank charges will be shown to you, and you have to confirm that the payment is for GATE 2013.
4. Once you confirm, you will be redirected back to the GATE Online Application Interface.
5. If you have some difficulty (due to internet connection or power failure), and you are not sure if you have made the payment, please login back to GATE Online Application Interface and check the status of the payment. You can also check the status in your bank.
6. In case the fee amount has been debited from your bank account but not reached GATE, then the money will be credited back to your account within three working days.
7. In such a case, you may initiate a fresh payment from the GATE Online Interface, even without waiting for the money to be credited back to your account, so that your application is submitted to GATE office on time. You may also switch to offline Challan payments if need be.

3.5.3.2 Offline Challan Payment Details

1. If you had chosen offline payment option while filling in the form, you will be provided with a copy of the challan in triplicate (PDF file) with your details filled in (see 13.C). You have to print it out on an A4 paper, and have to fill in a few more details such as date and signature.
2. You have to **wait for at least 48 hours after generation of application pdf online and only then take filled challan to the bank for payment of fees.**

3. You may take the challan to any Canara Bank or SBI and make application fees payment. You do not need to have an account in that branch.
4. The bank teller will verify the details printed on the challan with the data available at the bank and then accept the payment. Note that **your payment will NOT be accepted if you go to bank earlier than 48 hrs** as mentioned in 2 above. This is because it will take some time after application pdf generation online to reflect the data in respective bank's system.
5. The bank will retain one copy and give you back the remaining copies: one of which you have to send along with the printed application form and the other is for your reference.

3.5.4 Mailing Documents to GATE Office

The printed application form along with the documents must be mailed by **speed post** to the Zonal office, as mentioned in the printed address slip that comes along with the PDF file of the application form. Before mailing, the following procedures need to be completed

3.5.4.1 Before Mailing

1. Out of the printed pages, keep one copy of application form (page 2) for your reference and process the other copy as follows
 1. Paste a color photograph of yourself in the space provided, and sign the application in the box provided. This **photograph and signature should EXACTLY match the one in the photograph file uploaded** electronically to the GATE Online Interface; your application is liable to be rejected otherwise.
 2. Do not pin, sign, or attest the photograph
 3. You must sign in the box provided
 4. In case principal's certificate happens to be proof of your eligibility, Submit the whole page (**without cutting it**) to your College principal's office. Bottom portion of the form contains the part that your college principal has to certify. Once you obtain principal's signature and stamp this is ready to go in application packet to be sent.
2. If you had paid the application fee by challan, bank would have returned you stamped GATE copy of challan. Keep it ready to go in application packet to be sent.
3. You will also find half page of instruction and half page address slip. Cut this address slip, which contains the address of the Zonal office (along with application bar code), where the application form needs to be mailed.
4. Make sure you are ready with the following CHECK LIST:
 1. The **signed** application form (with **photograph** affixed) with, **Principal's certificate** if that is proof of your eligibility to appear in GATE 2013.
 2. Other **eligibility documents** to appear for GATE 2013 (degree certificate) in case pdf files of these are **NOT uploaded** to online interface.
 3. **Category certificate** for claiming discounted application fee in case pdf files of these are **NOT uploaded** to online interface.
 4. **PD certificate** if you require a scribe assistance

5. GATE copy of **Challan duly stamped** by the bank after payment of fees (you need not submit challan in case of payment by net banking)

3.5.4.2 Mailing

1. Use A4 sized envelope and put application form along with other documents mentioned in the CHECK LIST above.
2. **Do not fold** the application form and **DO NOT STAPLE** or pin the documents.
3. **Do not fill address by hand**, as the address slip provided contains a barcode necessary for processing your application. Note that barcodes on these address slips are different for each candidate. **DO NOT** use someone else's address slip for your application.
4. Secure the address slip firmly to the envelope using good glue or with additional transparent sticky tape (cello-tape)
5. Send the packet by **Speed Post (preferably)** or by Registered Post to the address mentioned. **The application packet should REACH the respective GATE offices on or before Monday, 8 October 2012.** Alternatively it can also be handed over personally to the respective Zonal GATE Office on or before Monday, 8th October 2012. (Note: Applications **reaching** respective offices later than 8th October 12 **may not be considered** even if they are post marked 8th October, 2012 or earlier)
6. If you had uploaded the supporting documents online, you should post only the application form page (with principal's certification if applicable). There is no need to post the paper copies of other documents.

Current status of your application will be updated after receipt and scrutinizing of your application by respective GATE offices. This status can be checked anytime by logging onto your GATE Online Applicant Interface.

3.5.5 Photograph and Signature Requirements









The GATE 2013 Online Applicant Interface requires that copies of your photograph and signature be uploaded as an electronic file at the time of submitting your application. Uploading photographs or signatures that do not meet specifications can result in disqualification of the application without any refund of the fee.

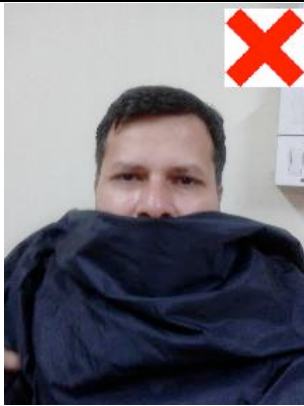
3.5.5.1 Photograph Requirements

Please pay attention to upload good quality photographs. Poor quality of photographs submitted will lead to rejection of your GATE application, without any refund of the application fees. The GATE Score card will be printed with the photograph you submit.

1. The photograph must be in color and must be taken in a professional studio. Photographs taken using a Mobile phone and other self-composed portraits are NOT acceptable.
2. Photograph must be taken in a White or a very light background.
3. The photograph must have been taken after 1 June 2012.
4. Face should occupy about 50% of the area in the photograph, and with a full-face view looking into the camera directly.
5. The main features of the face must not be covered by hair of the head, any cloth or any shadow. Forehead, both eyes, nose, cheeks, lip, and chin should be clearly visible.
6. If you normally wear spectacles, glare on glasses is not acceptable in your photo. Glare can be avoided with a slight downward tilt of the glasses for the photo shoot.
7. You must not wear spectacles with dark or tinted glasses, only clear glasses are permitted.
8. Ask your photo studio to provide the image in a JPEG format and also on a standard 4.5 cm x 3.5cm print
9. Maximum pixel resolution for JPEG: 640×480 (0.3 Mega pixel) (Ask your studio to reduce it to this resolution if it is higher)
10. Minimum pixel resolution for JPEG: 320 x 240.
11. For your own benefit it may be prudent not to intentionally change your facial features or hair style as in the photograph until the day of the exam.

3.5.5.2 Sample Photographs

Not Acceptable Photograph	Reason for Rejection	Acceptable
	Mobile phone; Distorted face	
	Blue Background	
	Facial Area is less than 50% of total	
	Not looking straight into Camera	



Cloth Covering facial features



Shadow on face



Improper flash or Improper Lighting



Too much glare on spectacles





3.5.5.3 Signature Specifications

1. Please put your signature with black or dark blue ink on a white paper.
2. Get the signature digitally photographed/image scanned by a professional photo studio, and get the image cropped by the studio itself.
3. Only JPEG image formats will be accepted.
4. The maximum pixel resolution for the image is 800 x 300.
5. The minimum pixel resolution for the image is 400 x 150.
6. Mobile phone photographs of signatures are not acceptable, and can result in disqualification of the application without any refund of the fee.

3.6 Admit Card

Admit card can only be downloaded from the zonal GATE websites from 5th December 2012 onwards. Sending Admit cards by post has been discontinued. Bring the downloaded admit card at the test center along with at least one original (not photocopied / scanned copy) and valid (not expired) photo identification. ONLY one of the following photo identifications is permitted: Driving license, Passport, PAN Card, Voter ID, College ID, Employee identification card, or a notarized Affidavit with Photo, Signature, Date of Birth and Residential Address. Photocopies of the original identification document are not acceptable. **Candidates will NOT be permitted to take the test, if original and valid photo identification is not presented.**

4 Examination Related Information

4.1 Structure of GATE 2013

A candidate can apply for only ONE of the 21 papers listed in Table given below. The syllabus for each of the papers is given separately. Making a choice of the appropriate paper during GATE application is the responsibility of the candidate. Some guidelines in this respect are suggested below.

The candidate is expected to appear in a paper appropriate to the discipline of his/her qualifying degree. The 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.

Table: List of GATE papers and corresponding codes

Sl. No.	Paper	Code	Sl. No.	Paper	Code
1	Aerospace Engineering	AE	12	Instrumentation Engineering	IN
2	Agricultural Engineering	AG	13	Mathematics	MA
3	Architecture and Planning	AR	14	Mechanical Engineering	ME
4	Biotechnology	BT	15	Mining Engineering	MN
5	Civil Engineering	CE	16	Metallurgical Engineering	MT
6	Chemical Engineering	CH	17	Physics	PH
7	Computer Science and Information Technology	CS	18	Production and Industrial Engineering	PI
8	Chemistry	CY	19	Textile Engineering and Fibre Science	TF
9	Electronics and Communication Engineering	EC	20	Engineering Sciences	XE*
10	Electrical Engineering	EE	21	Life Sciences	XL*
11	Geology and Geophysics	GG			
	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	M
	Food Technology	G			

* XE (Engineering Sciences) and XL (Life Sciences) papers are of general nature and will comprise of the sections listed in the above table. See further explanation below.

4.1.1 General Aptitude Questions

All the papers will contain few questions that test the General Aptitude (Language and Analytical Skills), apart from the core subject of the paper.

4.1.2 XE Paper

A candidate appearing in the XE paper has to answer the following

1. Section A – Engineering Mathematics
2. GA – General Aptitude
3. Any two of XE sections B to G

The choice of two out of the sections B to G can be made at the time of appearing for the exam after viewing the questions. Only two optional sections can be answered at a time. A candidate wishing to change from one optional to another optional section during the exam must first choose to deselect one of the previously chosen optional sections (B to G).

4.1.3 XL Paper

A candidate appearing in the XL paper has to answer the following

1. Section H – Chemistry
2. GA – General Aptitude
3. Any two of XL sections I to M

The choice of two out of the sections I to M can be made at the time of appearing for the exam after viewing the questions. Only two optional sections can be answered at a time. A candidate wishing to change from one optional to another optional section during the exam must first choose to deselect one of the previously chosen optional sections (I to M).

4.2 Duration and Exam Type

The GATE examination consists of a single paper of 3 hours duration that contains 65 questions carrying a maximum of 100 marks. The question paper will consist of only objective questions. The pattern of question papers is discussed separately in detail in Section 4.3.

The examination for the papers with codes AE, AG, AR, BT, CE, CH, CY, GG, PH, MA, MN, MT, TF, XE, and XL will be carried out as ONLINE computer based test where the candidates will be shown the questions in a random sequence on a computer screen. The candidates are required to enter the answer for each question using a mouse (keyboards will be disabled).

Candidates will be provided with blank paper sheets for rough work. At the end of the three hour window, the computer will automatically close the screen from further actions.

For all other papers (CS, EC, EE, IN, ME, and PI), the candidates will be given the questions printed on a paper, and they have to mark the correct choice on an Optical Response Sheet (ORS) by darkening the appropriate bubble against each question using a black ink ball point pen.

4.3 Pattern of Question Papers and Marking Scheme

4.3.1 Pattern of Question Papers

The examination for the papers with codes AE, AG, AR, BT, CE, CH, CY, GG, MA, MN, MT, PH, TF, XE and XL will be conducted ONLINE using computers where the candidates will be required to select the answer for each question using a mouse. For all other papers (CS, EC, EE, IN, ME & PI), the candidates will have to mark the correct choice on an Optical Response Sheet (ORS) by darkening the appropriate bubble against each question.

In all the papers, there will be a total of 65 questions carrying 100 marks, out of which 10 questions carrying total of 15 marks are in General Aptitude (GA). The remaining 85 % of the total marks is devoted to the syllabus of the paper (as indicated in the syllabus section).

GATE 2013 would contain questions of four different types in various papers:

(i) Multiple choice questions carrying 1 or 2 marks each; Each of the multiple choice objective questions in all papers and sections will contain four answers, of which one correct answer is to be marked.

(ii) Common data questions (which are also multiple choice questions), where two successive questions use the same set of input data;

Example

Statement for Common Data Questions, 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 $\text{Var}(X)=5/3$.

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

(iii) Linked answer questions (which are also multiple choice questions), where the answer to the first question in the pair is required to answer its successor;

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

An *E. coli* cell of volume 10^{-12} cm^3 contains 60 molecules of lac-repressor. The repressor has a binding affinity (K_d) of 10^{-8} M and 10^{-9} M with and without lactose respectively, in the medium.

First question of the pair:

Q.52 The molar concentration of the repressor in the cell is

- (A) 0.1 nM (B) 1 nM (C) 10 nM (D) 100 nM

Second question of the pair:

Q.53 Therefore the lac-operon is

- (A) repressed and can only be induced with lactose.
(B) repressed and cannot be induced with lactose.
(C) not repressed.
(D) expressed only when glucose and lactose are present.

(iv) Numerical answer questions, where the answer is a number, to be entered by the candidate.

Design of Questions

The questions in a paper may be designed to test the following abilities:

(i) Recall: These are based on facts, principles, formulae or laws of the discipline of the paper. 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 to

- (A) develop a starting torque
(B) compensate for auxiliary field ampere turns
(C) limit armature current at starting
(D) 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 answer 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 each other.

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

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.

Examples of each of this design is given in the types of questions above.

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 type questions.

4.4 Marking Scheme

For 1mark multiple-choice questions, 1/3 mark will be deducted for a wrong answer. Likewise, for 2 marks multiple-choice questions, 2/3 mark will be deducted for a wrong answer. However, for the linked answer question pair, where each question carries 2 marks, 2/3 mark will be deducted for a wrong answer to the first question only. There is no negative marking for wrong answer to the second question of the linked answer question pair. If the first question in the linked pair is wrongly answered or is unattempted, then the answer to the second question in the pair will not be evaluated. There is no negative marking for numerical answer type questions.

4.4.1 General Aptitude (GA) Questions

In all papers, GA questions are of multiple choice type, and carry a total of 15 marks. The GA section includes 5 questions carrying 1 mark each (sub-total 5 marks) and 5 questions carrying 2 marks each (sub-total 10 marks).

4.4.2 Question papers other than GG, XE and XL

These papers would contain 25 questions carrying one mark each (sub-total 25 marks) and 30 questions carrying two marks each (sub-total 60 marks). Out of these, two pairs of questions would be common data questions, and two pairs of questions would be linked answer questions. In the ONLINE papers, the question paper will consist of questions of multiple choice type and numerical answer type. For multiple choice type questions, each question will have four choices

for the answer. For numerical answer type questions, each question will have a number as the answer and choices will not be given. Candidates will have to enter the answer using a virtual keypad.

4.4.3 GG (Geology and Geophysics) Paper

Apart from the General Aptitude (GA) section, the GG 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 (Geo-physics). Candidates will have to attempt questions in Part A and either Section 1 or Section 2 in Part B.

Part A consists of 25 multiple-choice questions carrying 1-mark each (sub-total 25 marks & some of these may be numerical questions). Each section in Part B (Section 1 and Section 2) consists of 30 multiple-choice questions carrying 2 marks each (sub-total 60 marks and some of these may be numerical questions). Out of these, two pairs of questions would be common data questions, and two pairs of questions would be linked answer questions.

4.4.4 XE Paper (Engineering Sciences)

In XE paper, Engineering Mathematics section (Section A) is compulsory. This section contains 11 multiple-choice questions carrying a total of 15 marks: 7 questions carrying 1-mark each (sub-total 7 marks), and 4 questions carrying 2-marks each (sub-total 8 marks). Some of the multiple-choice questions may be replaced by numerical questions.

Each of the other sections of the XE paper (Sections B through G) contains 22 questions carrying a total of 35 marks: 9 questions carrying 1 mark each (sub-total 9 marks) and 13 questions carrying 2 marks each (sub-total 26 marks). Out of the 2 mark questions, 2 pairs are common data questions and 1 pair is linked answer questions. Some of the multiple choice questions may be replaced by numerical questions.

4.4.5 XL Paper (Life Sciences)

In XL paper, Chemistry section (Section H) is compulsory. This section contains 15 multiple-choice questions carrying a total of 25 marks: 5 questions carrying 1 mark each (sub-total 5 marks) and 10 questions carrying 2-marks each (sub-total 20 marks). Out of the 2-mark questions, 1 pair is common data questions, and 1 pair is linked answer questions. Some of the multiple-choice questions may be replaced by numerical questions.

Each of the other sections of the XL paper (Sections I through M) contains 20 multiple choice questions carrying a total of 30 marks: 10 questions carrying 1 mark each (sub-total 10 marks) and 10 questions carrying 2 marks each (sub-total 20 marks). Some of the multiple-choice questions may be replaced by numerical questions.

4.5 GATE Syllabi

4.5.1 General Aptitude (GA): Common to All Papers Engineering

1. **Verbal Ability:** English grammar, sentence completion, verbal analogies, word groups, instructions, critical reasoning and verbal deduction.
2. **Numerical Ability:** Numerical computation, numerical estimation, numerical reasoning and data interpretation.

Sample Questions

Verbal Ability

Q.1. Choose the appropriate answer to complete the following sentence:

After several attempts to send the missile into space, the spacecraft was finally launched successfully.

- (A) abortive (B) difficult (C) experimental (D) preliminary

Ans. (A)

Q.2. Choose the appropriate answer to complete the following sentence:

Medicine is to illness as law is to _____

- (A) discipline (B) anarchy (C) treason (D) etiquette

Ans. (B)

Q.3. Read the following paragraph:

“The ordinary form of mercury thermometer is used for temperature ranging from -40°F to 500°F . For measuring temperature below -40°F , thermometers filled with alcohol are used. These are, however, not satisfactory for use in high temperatures. When a mercury thermometer is used for temperature above 500°F , the space above the mercury is filled with some inert gas, usually nitrogen or carbon dioxide, placed in the thermometer under pressure. As the mercury rises, the gas pressures are increased, so that it is possible to use these thermometers for temperatures as high as 1000°F .”

With what, besides mercury, would a thermometer be filled if it was designed to be used for measuring temperature of about 500°F ?

- (A) Pyrometer (B) Inert gas (C) Iron and brass (D) Gas

Ans. (B)

Q.4. The cost of manufacturing tractors in Korea is twenty percent less than the cost of manufacturing tractors in Germany. Even after transportation fees and import taxes are added, it is still cheaper to import tractors from Korea to Germany than to produce tractors in Germany.

Which of the following assertions is best supported by the above information?

- (A) Labour costs in Korea are twenty percent below those in Germany.
- (B) Importing tractors into Germany will eliminate twenty percent of the manufacturing jobs in Germany.
- (C) The costs of transporting a tractor from Korea to Germany is more than twenty percent of the cost of manufacturing the tractor in Korea.
- (D) The import taxes on a tractor imported from Korea to Germany is less than twenty percent of the cost of manufacturing the tractor in Germany.

Ans. (D)

Numerical Ability

Q.5. In a survey, $\frac{3}{16}$ of the people surveyed told that they preferred to use public transport while commuting daily to office. $\frac{5}{8}$ of the people surveyed told that they preferred to use their own vehicles. The remaining 75 respondents said that they had no clear preference. How many people preferred to use public transport?

- (A) 75 (B) 100 (C) 125 (D) 133

Ans. (A)

4.5.2 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 Equations: 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.

4.5.3 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.

4.5.4 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 nouveau, 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.

4.5.5 Biotechnology (BT)

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.

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.

Biotechnology

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; 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.

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-polysaccharides, 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 transgenics.

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).

4.5.6 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.

4.5.7 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 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, 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.

4.5.8 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 datapath, 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.

4.5.9 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.