Graduate Aptitude Test in Engineering

GATE

Organizing Institute
Indian Institute of Technology Kanpur

2015

Information Brochure

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❖ 1. Introduction

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

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

❖ 2. About GATE

The Indian Institute of Science (IISc) and seven Indian Institutes of Technology (IITs at Bombay, Delhi, Guwahati, Kanpur, Kharagpur, Madras and Roorkee) jointly administer the conduct of GATE. The operations related to GATE in each of the 8 zones are managed by a zonal GATE Office at the IITs or IISc. The Organizing Institute (OI) is responsible for the end-to-end process and coordination amongst the administering Institutes. The Organizing Institute for **GATE 2015** is **IIT Kanpur.**

➢ 2.1. Financial Assistance

A valid GATE score is essential for obtaining financial assistance during Master's programs and direct Doctoral programs in Engineering/Technology/Architecture, and Doctoral programs in relevant branches of Science in Institutes supported by the MHRD or other Government agencies. As per the directives of the MHRD, the following procedure is to be adopted for admission to the post-graduate programs (Master's and Doctoral) with MHRD scholarship/assistantship. Depending upon the norms adopted by a specific institute or department of the Institute, a candidate may be admitted directly into a course based on his/her performance in GATE only **or** based on his/her performance in GATE **and** an admission test/interview conducted by the department to which he/she has applied **and/or** the candidate's academic record. If the candidate is to be selected through test/interview for post-graduate programs, a minimum of 70% weightage will be given to the performance in GATE and the remaining 30% weightage will be given to the candidate's performance in test/interview and/or academic record, as per MHRD guidelines. The admitting institutes could however prescribe a minimum passing percentage of marks in the test/interview. Some colleges/institutes specify GATE qualification as the mandatory requirement even for admission without MHRD scholarship/assistantship.

To avail of the financial assistance (scholarship), the candidate must first secure

admission to a program in these Institutes, by a procedure that could vary from institute to institute. Qualification in GATE is also a minimum requirement to apply for various fellowships awarded by many Government organizations. Candidates are advised to seek complete details of admission procedures and availability of MHRD scholarship/assistantship from the concerned admitting institution. The criteria for postgraduate admission with scholarship/assistantship could be different for different institutions. The management of the post-graduate 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 and/or award of scholarship/assistantship*.

➢ 2.2 Employment

Several public sector undertaking have, in the past, used GATE scores for screening for providing a salaried employment. A select few such organizations are: Indian Oil Corporation Limited, National Thermal Power Corporation, Power Grid India, etc.

Note: GATE administration is not responsible for employment opportunities. The qualified candidates must check newspapers and other reliable sources for any such information.

➢ 2.3 Administration

GATE is administered and conducted jointly by the Indian Institute of Science (IISc) and seven Indian Institutes of Technology (IITs) 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 these administering institutes, is the sole authority for regulating the examination and declaring the results.

GATE is conducted through the collaboration 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 co-ordination and responsibility of conducting **GATE 2015** lies with **Indian Institute of Technology Kanpur,** which is designated as the **Organizing**

Institute for GATE 2015.

❖ 3.Basic Features of GATE 2015

1. Examinations for **all the 22 papers** will be conducted by an **ONLINE** Computer Based Test (CBT). The online examination paper will contain some questions for which numerical answers must be keyed in by the candidate using the virtual keypad. Rest of the questions shall be of Multiple Choice Question (MCQ) type.
2. Biometric information (Photograph and Fingerprints) for randomly selected candidates may be captured before the start of the examination.
3. GATE 2015 examinations will be held during forenoon and afternoon sessions on alternate weekends (Saturday and Sunday) between 31st January 2015 and 14th February 2015. Examination for some of the papers in GATE 2015 will be held in multiple sessions. Exact details regarding complete examination schedule will be notified at a later date.
4. For GATE 2015 the entire process of filling up of application form, uploading of certificates/documents, etc., will be online and the candidates should **not** send any hard copy of their application form/documents, etc., to any of the IIT/IISc zonal GATE office.
5. The payment of application fees would be online through different modes like net banking, debit/credit card, e-challan, etc.
6. The admit cards for GATE 2015 would be available through the online process only. Candidates can download their admit card from GATE 2015 website. No hard copy of admit cards will be posted to the candidates.

➢ 3.1 General Information on GATE 2015

1. Application Process: For GATE 2015 all information related to the candidates will be available in a single GATE Online Application Processing System (GOAPS). Candidates have to register and fill the application via **ONLINE mode ONLY** by accessing the zonal GATE websites of IISc and any of the seven IITs. The photograph and signature of the applicant must be uploaded during the online application. Please note that all necessary certificates, such as, degree certificate/certificate from the Principal and the category certificate, if any are also to be uploaded. Please note that application forms are **not available for sale** anywhere else.

2. Downloadable Admit Card: Admit cards will **NOT** be sent by e-mail/post, they can **ONLY** be downloaded from the zonal GATE websites tentatively from 17th December 2014. The candidate has to bring the printed admit card to the test center along with at least one original (not photocopied/scanned copy) and valid (not expired) photo identification. It may be noted that one of the following photo identifications is **ONLY** permitted: Driving license, Passport, PAN Card, Voter ID, Aadhaar UID, College ID, Employee identification card, or a notarized affidavit with Photo, Signature, Date of Birth and Residential Address. The details of this ID proof have to be given while filling the online application.

3. Numerical Answer Type Questions: The question paper for GATE 2015 will consist of questions of both multiple-choice type and numerical answer type. For multiple choice type questions, candidates have to choose the answer from the given choices. For numerical answer type questions, choices will not be given. Candidates have to enter a number as the answer using a virtual keypad.

➢ 3.2 Important Dates Related to GATE 2015

Table 3.1: Important dates related to GATE 2015

GATE Online Application Processing System (GOAPS) Website Opens	**Monday**	**1st September 2014 (00:00 Hrs)**
Last Date for Submission of Online Application through Website	Wednesday	1st October 2014 (23:59Hrs)
Last Date for Request for Change in the Choice of City	Friday	21st November 2014
Availability of Admit Card on the Online Application Interface for printing	Wednesday	17th December 2014
GATE 2015 Online Examination Forenoon: 9.00 AM to 12.00 Noon Afternoon: 2.00 PM to 5.00 PM	Saturday and Sunday	31st January, 1st, 7th, 8th and 14th February, 2015
Announcement of Results on the Online Application Website	Thursday	12th March 2015 (17:00 Hrs)

❖ 4. Pre-Examination Related Information

➢ 4.1 Eligibility for GATE 2015

Before starting the application process, the candidate must ensure that he/she meets the eligibility criteria of GATE 2015 given in Table 4.1. So please study the following table carefully and make sure that your year of qualification is not later than what is specified.

Table 4.1: Eligibility Criteria for GATE 2015

Qualifying Degree	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 2014 or earlier	Expected to complete in 2015 or later
B.E./B.Tech./ B.Arch./ B.Pharm.	Bachelor's degree in Engineering/Technology/ Architecture/Pharmacy (Post-Diploma/Post B.Sc./ 4 years after 10+2)	Currently in the 4th year or already completed	2015	Degree Certificate /Provisional Certificate/Course Completion Certificate	Certificate from Principal
B.Sc. (Research)/ B.S.	Bachelor's degree in Science (Post-Diploma/ 4 years after 10+2)	Currently in the 4th year or already completed	2015	Degree Certificate /Provisional Certificate/Course Completion Certificate	Certificate from Principal
M. Sc./ M.A./MCA or equivalent	Master's degree in any branch of Science/Mathematics / Statistics / Computer	Currently in the final year or already	2015	Degree Certificate /Provisional Certificate/Course	Certificate from Principal

	Applications or equivalent	completed		Completion Certificate (pertaining to Master's degree)	
Int. M.E/ M.Tech (Post-B.Sc.)	Post-BSc Integrated Master's degree programs in Engineering / Technology (Four year program)	Currently in the 2nd/3rd/4th year or already completed	2017	Degree Certificate /Provisional Certificate/Course Completion Certificate	Certificate from Principal
Int. M.E./ M.Tech or Dual Degree(after Diploma or 10+2)	Integrated Master's degree program or Dual Degree program in Engineering / Technology (Five year program)	Currently in the 4th/5th year or already completed	2016	Degree Certificate /Provisional Certificate/Course Completion Certificate	Certificate from Principal
Int. M.Sc/ Int. B.S.-M.S.	Integrated M.Sc. or Five year integrated B.S.-M.S. program	Currently in the final year or already 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./B.Arch. 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 college Principal, as determined from Table 4.1, have to obtain one from his/her institution beforehand and upload the same during the online submission of the application form.

Candidates with Backlogs

Candidates, who have appeared in the final semester/year exam in 2014, but with a backlog (arrears/failed subjects) in any of the papers in their qualifying degree should

1. upload a copy of any one of the mark sheets of the final year,

OR

2. have to obtain a declaration from their Principal along with the signature and seal beforehand and upload the same during the online submission of the application form.

➢ 4.2 GATE Papers

GATE 2015 will be conducted in the subjects (also referred to as "papers") shown in Table 4.2. 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. A candidate is allowed to appear in **ONLY ONE** paper.

Since a candidate is allowed to appear in **ONLY ONE** of the 22 papers for which GATE 2015 examination is being held, the candidate has to make the choice of the paper he/she wishes to write carefully. Table 4.2 gives the list of GATE papers and paper codes for GATE 2015.

Table 4.2: GATE Papers and the Paper Codes for GATE 2015

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

*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		

➢ 4.3 Zone-wise List of Cities in which GATE 2015 will be Held

Choice of Examination City: There are two primary choices and one secondary choice. If you choose a particular city as your first choice, then the corresponding zone

to which this city belongs will appear, and you will be able to choose another city as your second choice only from this zone. These choices will be your primary choices in a specific zone. However, a third choice has also been introduced in GATE 2015, which is your secondary choice. The list of 3rd choice cities will be as specified by each zone and this will be used only when your cities of primary choice are not available. However, because of operational constraints, the GATE committee reserves the right to add a new city or remove an existing one, and allot a city that may not be any of the choices of a candidate.

Table 4.3 gives the tentative list of the cities (zone-wise) in which GATE 2015 will be held. Also shown in the table is the Zonal Offices (one of the IITs or IISc). The Zonal Office dealing with your application will be your point of contact for any enquiries regarding your examination center and other matters.

Table 4.3: Zone-wise examination city list for GATE 2015

Zone No.	Zonal GATE Office	Tentative List of Examination Cities*
1	IISc Bangalore Benguluru - 560 012 Website: http://gate.iisc.ernet.in/	Alappuzha, Aluva, Ananthapur, Attingal, Bagalkot, Bangalore, Bellary, Belgaum, Bidar, Chengannur, Davengere, Gulbarga, Hassan, Hubli, Idukki, Kannur, Kanjirapally, Kasaragod, Kolar, Kollam, Kothamangalam, Kottayam, Kozhikode, Kurnool, Malappuram, Mangalore, Manipal, Muvattupuzha, Mysore, Nedumangad, Pala, Palakkad, Payyannur, Port Blair, Punalur, Shimoga, Thrissur, Tumkur and Vadakara
2	IIT Bombay, Powai, Mumbai - 400 076 Website: http://www.gate.iitb.ac.in/	Ahmedabad, Ahmednagar, Amravati, Anand, Aurangabad, Bhavnagar, Bhuj, Gandhinagar, Goa, Hyderabad, Jalgaon, Kolhapur, Lonawala, Mehsana, Mumbai, Nagpur, Nanded, Nashik, Navi Mumbai, Pune, Rajkot, Ratnagiri, Sangli, Satara, Secunderabad, Solapur, Surat, Thane and Vadodara
3	IIT Delhi, HauzKhas, New Delhi – 110016 Website: http://gate.iitd.ac.in/	Ajmer, Alwar, Bahadurgarh, Bikaner, New Delhi, Delhi-NCR, Faridabad, Gurgaon, Hisar-Rohtak, Indore, Jammu, Jaipur, Jodhpur, Karnal, Kota, Mathura, Palwal, Sikar, Udaipur-Chittorgarh and Ujjain
4	IIT Guwahati Guwahati – 781039 Website: http://www.iitg.ernet.in/gate/	Agartala, Asansol,Dhanbad, Durgapur, Gangtok, Guwahati, Imphal, Jorhat, Kalyani, Patna, Silchar, Siliguri, Shillong and Tezpur
5	IIT Kanpur Kanpur – 208016 Website: http://gate.iitk.ac.in/	Agra, Aligarh, Allahabad, Bareilly, Bhopal, Gwalior, Jabalpur, Kanpur, Lucknow and Varanasi
6	IIT Kharagpur Kharagpur – 721302 Website: http://gate.iitkgp.ac.in/	Balasore, Berhampur (Odisha), Bhilai, Bhimavaram, Bhubaneswar, Bilaspur (CG), Cuttack, Eluru, Hooghly, Jamshedpur, Kakinada, Kharagpur, Kolkata, Raipur, Rajahmundry, Ranchi, Rourkela, Sambalpur, Tadepalligudem, Vijayawada, Visakhapatnam and Vizianagaram
7	IIT Madras Chennai – 600036 Website: http://gate.iitm.ac.in/	Angamaly , Bapatla, Chennai North, Chennai South, Chittoor, Coimbatore, Cuddalore, Dindigul, Ernakulam, Erode, Gudur, Guntur, Kadapa, Kanyakumari, Karimnagar, Karur, Khammam, Madurai, Nagercoil, Nalgonda, Namakkal, Nellore, Ongole, Puducherry (Pondicherry), Salem, Thanjavur, Thiruchengode, Thiruvannamalai, Thiruvananthapuram, Tiruchirapalli, Tirunelveli, Tirupati, Tuticorin, Vellore, Villupuram, Virudhunagar and Warangal
8	IIT Roorkee Roorkee – 247667 Website: http://www.iitr.ac.in/gate/	Ambala, Amritsar, Bathinda, Chandigarh-Mohali-Fatehgarh Sahib, Dehradun, Ghaziabad, Haldwani-Bhimtal, Hamirpur (HP)-Una, Jalandhar-Phagwara, Kurukshetra, Ludhiana-Moga, Meerut, Moradabad, Noida, Panchkula, Panipat, Pathankot, Patiala-Sangrur, Roorkee-Muzaffarnagar, Saharanpur, Sirmaur, Solan-Shimla, Sonepat and Yamunanagar

*** Please consult GATE 2015 website for complete list of cities.**

➢ 4.4 How to Apply

All candidates have to apply **only ONLINE**. Details of the application fee are shown in Table 4.4. **The application fee is non-refundable.**

Table 4.4: Details of application fee for GATE 2015

Male Candidates (General/OBC)	₹ 1500/-
Women Candidates of any category	₹ 750/-
Other Candidates (General/OBC)	₹ 1500/-
SC / ST / PwD* Category Candidates	₹ 750/-

*** PwD: Person with a Physical Disability**

For **GATE 2015** payments would have to be made through online by selecting either using any bank Debit Card/Credit Card, Net Banking or e-challan facilities **ONLY**. **Additional charges** will be applicable as per the rule of the bank from where the money is being transferred. Table 4.5 gives the charges as applicable for State Bank of India (SBI) and Axis Bank where the GATE 2015 account is opened and where the money is to be transferred.

► 4.4.1 GATE Online Application Processing System (GOAPS)

An online interface is provided for your interaction with the GATE Office. With this interface you can

1. Apply for the examination online.
2. Upload photograph, signature and other documents like graduation certificate/ certificate from Principal, caste certificate (if applicable) etc.
3. Pay the application fee through net-banking.
4. Check the Status of your application form: Received, Under Scrutiny, Accepted, Defect Status, Status after Rectification, Rejected with Valid Reasons, Admit Card Ready for Download, etc.
5. Contact the Zonal GATE Offices in case of any queries/problems.
6. Download Admit Card.
7. View your answers, marks and GATE score.

The login to this interface is through your GOAPS Enrolment ID and a GOAPS password. Keep this information safe and do not disclose it to anyone.

▶ 4.4.2 Filling in Application Online

1. **GOAPS:** GATE Online Application Processing System (GOAPS website) can be accessed from the website of the respective Zonal GATE Offices or from the website of the GATE 2015 Organizing Institute.

2. **Registration:** You must first register yourself, by providing a valid email address, mobile number and a GOAPS password. Choose the email id that you check frequently, as all communications to you from the GATE Offices will be sent to this address (DO NOT USE ANYBODY ELSE'S e-mail ADDRESS. ONLY ONE PERSON CAN REGISTER WITH ONE e-mail ADDRESS). Give your personal mobile number because most of the communications may also be sent via SMS.

   GOAPS Password: This will be the password that you will be providing to the GOAPS during the Enrollment. You must remember this along with the GOAPS Enrolment ID to login to GOAPS. Choose a password that cannot be guessed easily (it should not be your name, date of birth, or some string of numbers or letters like 12345, abcd, etc.), so as to ensure that the data you provide is not accessible to any person other than yourself.

3. **GOAPS Enrollment ID:** Upon registration, an email containing your GOAPS Enrolment ID will be sent to you. You need to remember this along with the GOAPS password for all GATE 2015 related communications/website operations.

4. **Data Requirement for Application Filling:** Before you login to GOAPS using Enrolment ID and Password, keep the following information ready:

   a) Personal information (name, date of birth, your personal mobile number, parent's name, parent's mobile number, etc.).

   b) Address for Communication (including PIN code),

   c) Eligibility degree details (College address, PIN code of college),

   d) GATE paper, choice of GATE examination cities,

   e) High quality image of your photograph conforming to the requirements specified in Section 4.4.4.1, along with what type of photograph is accepted (Section 4.4.4.2).

   f) Good quality image of your signature conforming to the requirements specified in Section 4.4.4.3.

   g) Scanned copy of Degree Certificate or Certificate from Principal/HODs in pdf format.

   h) Scanned copy of Category/PwD Certificate (if applicable) in pdf format.

   i) Details of a valid ID Proof that you will carry to the examination hall.

   j) Your Net-banking login and password to make the application fee payment via online net-banking mode. In case you are making the payment through debit

card/credit card have the following information like debit card/credit card number, password, CVV number ready with you.

5. **Application Filling:** Fill in the necessary data in the online application form by carefully following instructions given there. You may edit the data at this stage if you require. Upload the required soft copy of photo, signature and Certificate from Principal (duly signed and stamped by the Principal). Check the correctness of the photo and your signature and documents that are uploaded. If the uploaded soft copy is not correct or you are not satisfied with the quality of the soft copy, you may upload them again.

6. You will have to select the payment option (details given below) while filling the online form.

7. The GOAPS allows you to enter data, "Save" partially filled form, "Logout", and resume filling in by logging in again.

8. Before you make the payment, you will be shown a "Preview" of your application, where you have to carefully check for any errors.

9. Once you press **"Confirm and Final Submit"** button**, no further changes to the application can be made by you.**

10. For online payment follow the instructions given in Section 4.4.3 for payment options.

11. **Problems in Login into GOAPS –**This step may be used, if the candidate forgets the password or the Enrollment ID or did not receive the Enrollment ID. Visit the "**Problems in Login into GOAPS"** link on the GOAPS website**.**

    a) ***In case of forgotten Enrollment ID or non-receipt of Enrollment ID via email***, candidate must provide mobile number and the GOAPS Password. The Enrollment ID will be sent to the candidate via SMS.

    b) ***In case of forgotten password***, candidate must provide Mobile Number and Enrollment ID, which will be verified and a new GOAPS password will be sent to the candidate via SMS/email.

    c) ***In case of forgotten Enrollment ID as well as password or payment has not been made***, the candidate must re-enroll. If the ***payment has been made***, then the candidate must contact the Zonal GATE Office.

4.4.2.1 Supporting Documents

4.4.2.1.1 Eligibility Documents

Eligibility criteria and necessary supporting documents can be found from the eligibility table for GATE (Table 4.1).

4.4.2.1.2 SC/ST/PwD Certificate

Candidates who are in any of the above categories have to upload a valid documentary evidence (Appendix A).

4.4.2.1.3 Certificate from Principal

Candidates who mention that they are yet to complete their course, will receive a "Certificate from Principal" section printed on the bottom part of the PDF file. Before you upload this certificate, it is **MANDATORY** to obtain the signature and seal of the college Principal on this.

4.4.3 Application Fee Payment Options

The application fee and various payment options are shown in Table 4.5. **The application fee is non-refundable**. All charges given below are in Indian Rupees.

Table 4.5: Application fee and Payment Options

Candidate Category	Mode	Application Fee in ₹*
Male (General/OBC)	Online Net Banking	1500
	e-challan	1500
Women (All Categories)	Online Net Banking	750
	e-challan	750
Other (General/OBC-NCL)	Online Net Banking	1500
	e-challan	1500
SC/ST/PwD	Online Net Banking	750
	e-challan	750

*** - Bank charges will be applicable as per the norm.**

4.4.3.1 Online Net-banking Payment Details

1. From the GATE Online Application Processing System (GOAPS), you will be redirected to the website of the bank of your choice.
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 2015.
4. Once you confirm and the payment is successful, you will be redirected back to the GATE Online Application Website.
5. If you have some difficulty (due to internet connection or power failure), and you are not sure whether your payment has been processed or not, then please login back to GOAPS and check the status of the payment. You can also check the status from your bank.
6. In case the fee amount has been debited from your bank account/debit card/credit card, however, GOAPS does not acknowledge any fee payment, then the money will be credited back to your account/debit card/credit card within three working days.

7. In such a case, you may initiate a fresh payment using GOAPS, even without waiting for the money to be credited back to your account/debit card/credit card, so that your application is on time.

4.4.3.2 Online Net Banking Payment Procedure

1. At the secure payment site choose the method of payment which is Net Banking/e-challan.
2. Login with your Net Banking/SBI/Axis Bank "User Name" and "Password".
3. Follow the instruction as shown and fill in the details and make the payment. The details of the process of how to fill through Net Banking/e-challan may be seen at http://gate.iitk.ac.in/.
4. Once the payment is successful a "Fee Payment Number" will be generated which is unique and **MUST be saved by the candidate** as it will be used in the later stages when he/she fills up the GATE 2015 Application form.
5. After successful payment of the Application Fees the candidate will be required to fill in his/her details (as given in Section 4.4.2) to complete the GATE 2015 Application process.
6. It is essential that the candidate fills in the details (as given in Section 4.4.2) without any error as the application **is liable to be rejected if there is any error**. As a checklist the candidate MUST verify that he/she has filled in and uploaded the following as required
    a) Personal information (name, date of birth, your personal mobile number, parent's name, parent's mobile number etc.).
    b) Address for Communication (including PIN code).
    c) Eligibility degree details (College address, PIN code of college).
    d) The signed application form (with photograph affixed) with Principal's certificate, if that is the proof of your eligibility to appear in GATE 2015 **OR** Other eligibility documents required to appear in GATE 2015 (e.g., degree certificate).
    e) High quality image of your photograph conforming to the requirements specified in Section 4.4.4.1, along with what type of photograph is accepted (Section 4.4.4.2)
    f) **Category certificate ONLY** for claiming discounted application fee.
    g) Good quality image of your signature conforming to the requirements specified in Section 4.4.4.3.
    h) Details of a valid ID Proof that you will carry to the examination hall.
    i) **Fee payment number**.

Note: Before submitting the GATE 2015 Application please ensure that all the details and all the necessary supporting documents are filled/uploaded and there is NO ERROR. Application once submitted CANNOT be changed/rectified. The current status of your application will be updated after the receipt and scrutiny of your application by the respective zonal GATE Office. This status can be checked anytime by logging into GOAPS.

4.4.4 Photograph and Signature Requirements

The GATE 2015 Online Application Processing System requires that your photograph and signature be uploaded electronically at the time of submitting your application. Uploading photograph or signature that does not meet the specifications can result in the disqualification of the application without any refund of the application fee.

4.4.4.1 Photograph Requirements

Please pay attention to upload good quality photograph. Poor quality of the photograph submitted will lead to rejection of your GATE application, without any refund of the application fee. 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. Photograph taken using a mobile phone and other self-composed portraits are NOT acceptable.
2. The photograph must be taken in a white or a very light background.
3. The photograph must have been taken after 1st July 2014.
4. In the photograph, the face should occupy about 50% of the area, 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, eyes, nose 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 or by removing 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 3.5 cm × 4.5 cm (Width x Height) print.
9. Maximum pixel resolution for JPEG: 480 × 640 (0.3 Mega pixel) (Ask your studio to reduce it to this resolution if it is higher).
10. Minimum pixel resolution for JPEG: 240 × 320.

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.

4.4.4.2 Sample Photographs

Not Acceptable Photograph	Reason for Rejection	Acceptable
	Photo taken with mobile phone; Distorted face	
	Blue background	
	Facial area is less than 50% of total	
	Not looking straight into camera	
	Cloth covering facial features	

Not Acceptable Photograph	Reason for Rejection	Acceptable
	**Shadow on face**	
	**Improper flash or Improper lighting**	
	**Too much glare on spectacles**	
	**Dark/Tinted Spectacles or Sunglasses**	
	**Poor Digital Resolution (100×75)**	

4.4.4.3 Signature Specifications

1. Please draw a rectangular box of size 2 cm × 7 cm (Height x Width) on an A4 white paper. Put your signature with black or dark blue ink pen within this box.
2. Get the signature digitally image scanned by a professional using a scanner, and get the image cropped to the box by the professional.
3. Only JPEG image formats will be accepted.
4. The maximum pixel resolution for the image is 160 × 560.
5. The minimum pixel resolution for the image is 80 × 280.
6. Photographs of the signatures taken using mobile phone are not acceptable, and can result in disqualification of the application without any refund of the fee.

4.5 Admit Card

The Admit Card can only be downloaded from the zonal GATE websites tentatively from 17th December 2014. Admit Cards will NOT be sent by post/email. Bring a print-out of the downloaded Admit Card to the Test Center along with the original and valid photo identification(NO photocopy / scanned copy/NOT expired). **Please note that you have to give details of this ID proof while filling the online application.** Candidates will **NOT** be permitted to take the test, if this original and valid photo identification is not presented. It may be noted that you would have specified one of the following IDs during the online application process: Driving License, Passport, PAN Card, Voter ID, Aadhaar UID, College ID, Employee Identification Card, or a Notarized Affidavit with Photo, Signature, Date of Birth and Residential Address.

5. Examination Related Information

5.1 Structure of GATE 2015

For the GATE 2015 examination, a candidate can apply for only one of the 22 papers listed in Table 5.1. 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. However, the candidate is, 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. For more details regarding the admission criteria in any particular institute, the candidate is advised to refer to the websites of that institute.

Table 5.1: List of GATE Papers and Corresponding Codes

Paper	Code
Aerospace Engineering	AE
Agricultural Engineering	AG
Architecture and Planning	AR
Biotechnology	BT
Civil Engineering	CE
Chemical Engineering	CH
Computer Science and Information Technology	CS
Chemistry	CY
Electronics and Communication Engineering	EC
Electrical Engineering	EE
Ecology and Evolution	EY

Paper	Code
Geology and Geophysics	GG
Instrumentation Engineering	IN
Mathematics	MA
Mechanical Engineering	ME
Mining Engineering	MN
Metallurgical Engineering	MT
Physics	PH
Production and Industrial Engineering	PI
Textile Engineering and Fibre Science	TF
Engineering Sciences	XE*
Life Sciences	XL**

* XE PAPER SECTIONS	CODE
Engineering Mathematics (Compulsory)	A
Fluid Mechanics	B
Materials Science	C
Solid Mechanics	D
Thermodynamics	E
Polymer Science and Engineering	F
Food Technology	G

**XL PAPER SECTIONS	CODE
Chemistry (Compulsory)	H
Biochemistry	I
Botany	J
Microbiology	K
Zoology	L
Food Technology	M

*XE (Engineering Sciences) and **XL (Life Sciences) papers are of general nature and will comprise of Sections listed in the above table. More detailed explanation is given below.

▶ 5.1.1 General Aptitude Questions

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

▶ 5.1.2 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 sections from B to G can be made during the examination after viewing the questions. Only two optional sections can be answered at a time. A candidate wishing to change midway of the examination to another optional section must first choose to deselect one of the previously chosen optional sections (B to G).

▶ 5.1.3 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 sections from I to M can be made during the examination after viewing the questions. Only two optional sections can be answered at a time. A candidate wishing to change midway of the examination to another optional section must first choose to deselect one of the previously chosen optional sections (I to M).

➢ 5.2 Duration and Examination Type

The GATE examination consists of a single paper of **3-hour** duration that contains **65** questions carrying a maximum of **100 marks**. The question paper will consist of both multiple choice questions (MCQ) and numerical answer type questions. The pattern of question papers is discussed in Section 5.3.

The examination for all the papers will be carried out in an ONLINE Computer Based Test (CBT) mode where the candidates will be shown the questions in a random sequence on a computer screen. The candidates are required to either select the answer (for MCQ type) or enter the answer for numerical answer type question using a mouse on a virtual keyboard (keyboard of the computer will be disabled). Candidates will be provided with scribble pad for rough work and these have to be returned back after the examination. At the end of the 3-hour window, the computer will automatically close the screen from further actions.

➢ 5.3 Pattern of Question Papers

▶ 5.3.1 Pattern of Question Papers

In all the papers, there will be a total of 65 questions carrying 100 marks, out of which 10 questions carrying a total of 15 marks are in General Aptitude (GA).

In the papers bearing the codes AE, AG, BT, CE, CH, CS, EC, EE, IN, ME, MN, MT, PI, TF and XE, the Engineering Mathematics will carry around **15% of the total marks**, the General Aptitude section will carry **15% of the total marks** and the **remaining 70% of the total marks** is devoted to the subject of the paper.

In the papers bearing the codes AR, CY, EY, GG, MA, PH and XL, the General Aptitude section will carry **15% of the total marks** and the **remaining 85% of the total marks** is devoted to the subject of the paper.

GATE 2015 would contain questions of two different types in various papers:

(i) Multiple Choice Questions (MCQ) carrying 1 or 2 marks each in all papers and sections. These questions are objective in nature, and each will have a choice of four answers, out of which the candidate has to mark the correct answer(s).

(ii) Numerical Answer Questions of 1 or 2 marks each in all papers and sections. For these questions the answer is a real number, to be entered by the candidate using the virtual keypad. No choices will be shown for this type of questions.

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

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

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

(iv) ***Analysis and Synthesis*****:** In these questions, the candidate is presented with data, diagrams, images etc. that require analysis before a question can be answered. A *Synthesis* question might require the candidate to compare two or more pieces of information. Questions in this category could, for example, involve candidates in recognizing unstated assumptions, or separating useful information from irrelevant information.

➢ 5.4 Marking Scheme

For **1-mark** multiple-choice questions, **1/3** marks will be deducted for a wrong answer. Likewise, for **2-mark** multiple-choice questions, **2/3** marks will be deducted for a wrong answer. **There is NO negative marking for numerical answer type questions**.

▶ 5.4.1 General Aptitude (GA) Questions

In all papers, GA questions 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**).

▶ 5.4.2 Question Papers other than GG, XE and XL

These papers would contain **25** questions carrying **1-mark** each (sub-total **25 marks**) and **30** questions carrying **2-marks** each (sub-total **60 marks**). The question paper will consist of questions of multiple choice and numerical answer type. For numerical answer questions, choices will not be given. Candidates have to enter the answer (which will be a real number, signed or unsigned, e.g., 25.06, -25.06, 25, -25 etc.) using a virtual keypad. An appropriate range will be considered while evaluating the numerical answer type questions so that the candidate is not penalized due to the usual round-off errors.

▶ 5.4.3 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** and some of these may be numerical answer type 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 answer type questions).

► 5.4.4 XE Paper (Engineering Sciences)

In XE paper, Engineering Mathematics section (Section A) is **compulsory**. This section contains **11** 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 questions may be of numerical answer type 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**). Some questions may be of numerical answer type.

► 5.4.5 XL Paper (Life Sciences)

In XL paper, Chemistry section (Section H) is **compulsory**. This section contains **15** 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**). Some questions may be of numerical answer type.

Each of the other sections of the XL paper (Sections I through M) contains 20 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 questions may be of numerical answer type.

► 5.4.6 Note on Negative Marking for Wrong Answers

For a wrong answer chosen for the **multiple choice questions** (MCQs), there would be negative marking. For **1-mark** multiple choice questions, **1/3** mark will be deducted for a wrong answer. Likewise, for **2-mark** multiple choice questions, **2/3** mark will be deducted for a wrong answer. However, there is **NO negative marking for a wrong answer in numerical answer type questions**.

❖ 5. 5. GATE Syllabi

▶ 5.5.1 General Aptitude (GA): Common to All Papers

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 were 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 is 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 are 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, 3/16 of the people surveyed told that they preferred to use public transport while commuting daily to office. 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)

► 5.5.2 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; takeoff 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, KuttaJoukowski 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 visualization 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.

Turbo machinery: 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.

▶ 5.5.3 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 leveling; contouring; instruments for surveying and leveling; 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 evapo-transpiration; 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-vapors 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.

► 5.5.4 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; neighborhood 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: Behavioral 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.

► 5.5.5 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 bio macromolecules; 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-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; Tot potency; 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).

► 5.5.6 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 analysisinsands& 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.

► 5.5.7 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 equilibrium.

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; stage-wise 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.

▶ 5.5.8 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.

Combinatory*:* 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.

► 5.5.9 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 interhalogencompounds.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 andMo.

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 stereogeniccentres. Enantiotopic and diastereotopic atoms, groups and faces.Stereoselective and stereospecific synthesis.Conformational analysis of acyclic and cyclic compounds.Geometricalisomerism.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.

► 5.5.10 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 usingLaplace 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 ofLaplace 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.

▶ 5.5.11 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.

▶ 5.5.12 Ecology and Evolution (EY)

Ecology

Population ecology; metapopulation dynamics; growth rates; density independent growth; density dependent growth; niche concept; Species interactions: Plant-animal interactions; mutualism, commensalism, competition and predation; trophic interactions; functional ecology; ecophysiology; behavioural ecology; Community ecology: Community assembly, organization and evolution; biodiversity: species richness, evenness and diversity indices; endemism; species-area relationships; Ecosystem structure, function and services; nutrient cycles; biomes; habitat ecology; primary and secondary productivity; invasive species; global and climate change; applied ecology.

Evolution

Origin, evolution and diversification of life; natural selection; levels of selection. Types of selection (stabilizing, directional etc.); sexual selection; genetic drift; gene flow; adaptation; convergence; species concepts; Life history strategies; adaptive radiation; biogeography and evolutionary ecology; Origin of genetic variation; Mendelian genetics; polygenic traits, linkage and recombination; epistasis, gene-environment interaction; heritability; population genetics; Molecular evolution; molecular clocks; systems of classification: cladistics and phenetics; molecular systematics; gene expression and evolution.

Mathematics and Quantitative Ecology

Mathematics and statistics in ecology; Simple functions (linear, quadratic, exponential, logarithmic, etc); concept of derivatives and slope of a function; permutations and combinations; basic probability (probability of random events; sequences of events, etc); frequency distributions and their descriptive statistics (mean, variance, coefficient of variation, correlation, etc).

Statistical hypothesis testing: Concept of p-value; Type I and Type II error, test statistics like t-test and Chi-square test; basics of linear regression and ANOVA.

Behavioural Ecology

Classical ethology; neuroethology; evolutionary ethology; chemical, acoustic and visual signaling Mating systems; sexual dimorphism; mate choice; parenting behaviour Competition; aggression; foraging behaviour; predator–prey interactions; Sociobiology: kin selection, altruism, costs and benefits of group-living.

5.5.13 Geology and Geophysics (GG)

5.5.13.1 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 ofIndia. Engineering properties of rocks and soils. Ground water geology.Geological and geographical distribution of ore, coal and petroleum resources ofIndia.

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.

5.5.13.2 Part B – Section 1: Geology

Crystalsymmetry, 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.

Oremineralogy and optical properties of ore minerals; ore forming processes vis-à-vis ore-rock association (magmatic, hydrothermal, sedimentary and metamorphogenic ores); oresand 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 inIndia; 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.

5.5.13.3 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.

▶ 5.5.14 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.Feedbackamplifiers.Operational amplifiers, characteristics and circuit configurations.Instrumentationamplifier.Precisionrectifier.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.

► 5.5.15 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

Legendrequadrature, 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 -u 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.

▶ 5.5.16 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.

▶ 5.5.17 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.

▶ 5.5.18 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.

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.

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.

▶ 5.5.19 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 includingboundary value problems;dielectricsandconductors; 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;Rutherfordscattering,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.

▶ 5.5.20 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, electro slag, 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, planning, 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; methodstudy, 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.

▶ 5.5.21 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.

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.

Textile Engineering andFiber Science

Textile Fibers: Classification of textile fibers; Essential requirements of fiber forming polymers; Gross and fine structure of natural fibers like cotton, wool and silk. Introduction to important bastfibres; properties and uses of natural and man-made fibers; physical and chemical methods of fiber 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 ofman-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 set of woven fabrics.

Textile Testing: Sampling techniques, sample size and sampling errors. Measurement of fibre length, fineness, crimp, strength and reflectance; measurement of cotton fiber maturity and trash content; HVI and AFIS for fibre testing. Measurement of yarn count, twist and hairiness; tensile testing of fibers, 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. Batch wise 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.Printingauxiliaries.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.Antis tat finishing of synthetic fiberfabrics.Heat setting of polyester.

Energy Conservation: Minimum application techniques.

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

5.5.22 Engineering Sciences (XE)

5.5.22.1 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.

5.5.22.2 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.

5.5.22.3 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.

5.5.22.4 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.

5.5.22.5 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, Clausiusinequality 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.

5.5.22.6 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, cross-linking 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. Visco-elasticity-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.

5.5.22.7 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.

▶ 5.5.23 Life Sciences (XL)

🔹 5.5.23.1 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, Trouton's 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 aromatic city.

🔹 5.5.23.2 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.

5.5.23.3 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.

5.5.23.4 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.

5.5.23.5 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.

5.5.23.6 Section M: 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.

❖ 6. Post-Exam Related Information

➢ 6.1 GATE Score

After the evaluation of the answers, the raw marks obtained by a candidate will be converted to a normalized GATE Score.

From 2013 onwards, the GATE score of a candidate is being computed using the formula given below.

Calculation of Normalized Marks for CE, CS, EC, EE and ME papers (multi-session papers)

In 2015, examination for CE, CS, EC, EE and ME papers will be conducted in multi-sessions. Hence, for these papers, a suitable normalization is applied to take into account any variation in the difficulty levels of the question papers across different sessions. The normalization is done based on the fundamental assumption that "in all multi-session GATE papers, the distribution of abilities of candidates is the same across all the sessions". This assumption is justified since the number of candidates appearing in multi-session papers in GATE 2015 is large and the procedure of allocation of session to candidates is random. Further it is also ensured that for the same multi-session paper, the number of candidates allotted in each session is of the same order of magnitude.

Based on the above, and considering various normalization methods, the committee arrived at the following formula for calculating the normalized marks, for CE, CS, EC, EE and ME papers.

Normalization mark of j^{th} candidate in the i^{th} session $\widehat{M}_{ij}$ is given by

$$\widehat{M}_{ij} = \frac{\bar{M}_t^g - M_q^g}{\bar{M}_{ti} - M_{iq}}\left(M_{ij} - M_{iq}\right) + M_q^g$$

where

M_{ij}: is the actual marks obtained by the j^{th} candidate in i^{th} session

$\bar{M}_t^g$: is the average marks of the top 0.1% of the candidates considering all sessions

M_q^g: is the sum of mean and standard deviation marks of the candidates in the paper considering all sessions

$\bar{M}_{ti}$: is the average marks of the top 0.1% of the candidates in the i^{th} session

M_{iq}: is the sum of the mean marks and standard deviation of the i^{th} session

After the evaluation of the answers, normalized marks based on the above formula will be calculated corresponding to the raw marks obtained by a candidate for CE, CS, EC, EE and ME papers and the GATE 2015 Score will be calculated based on the normalized marks.

For all other papers, actual marks obtained will be used for calculating the GATE 2015 Score.

Calculation of GATE Score for all papers

GATE 2015 score will be calculated using the formula

$$GATE\ Score = S_q + (S_t - S_q)\frac{(M - M_q)}{(\bar{M}_t - M_q)}$$

In the above formulae

M: marks obtained by the candidate (actual marks for single session papers and normalized marks for multi-session papers)

M_q: is the qualifying marks for general category candidate in the paper

$\bar{M}_t$: is the mean of marks of top 0.1% or top 10 (whichever is larger) of the candidates who appeared in the paper (in case of multi-session papers including all sessions)

S_q: 350, is the score assigned to M_q

S_t: 900, is the score assigned to $\bar{M}_t$

In the GATE 2015 score formula, M_q is usually 25 marks (out of 100) or $+\sigma$, whichever is larger. Here μ is the mean and σ is the standard deviation of marks of all the candidates who appeared in the paper.

After the declaration of the results, GATE Scorecards can be downloaded by (a) All SC/ST/PwD candidates whose marks are greater than or equal to the qualifying mark of SC/ST/PwD candidates in their respective papers, and (b) All other candidates whose marks are greater than or equal to the qualifying mark of OBC (NCL) candidates in their respective papers. **There is no provision for the issue of hard copies of the GATE Scorecards**.

The GATE 2015 Committee has the authority to decide the qualifying mark/score for each GATE paper. In case any claim or dispute arises in respect of GATE 2015, it is hereby made absolutely clear that the Courts and Tribunals in Allahabad and Allahabad alone shall have the exclusive jurisdiction to entertain and settle any such dispute or claim.

➢ 6.2 GATE 2015 Results

GATE 2015 **results will be announced on March 12, 2015 at 17:00 hrs** and will be available on the GATE Online Application Website.

GATE 2015 score is valid for **THREE YEARS** from the date of announcement of the results.

GATE 2015 results may be made available on payment basis to Government organizations (educational institutions, R & D laboratories, industries, etc.) in India and abroad based on a Memorandum of Understanding (MOU) between IIT Kanpur and the organization intending to use the GATE score. Details in this regard can be obtained from The Organising Chairman, GATE 2015, IIT Kanpur.

➢ 6.3 GATE 2015 Score Card

After the declaration of the results, candidates can download their GATE 2015 Score Card for the paper (for which he/she has taken the examination). Downloadable score cards will be available to only those candidates whose marks are equal to or above the qualifying marks of SC/ST/PwD candidates in that paper. The GATE 2015 score cards

can be downloaded between March 27, 2015 to May 29, 2015 and for that the candidate should access the zonal websites from where he/she has taken the GATE 2015 examination.

In case any candidate requires the soft copy of his/her GATE Score Card after May 29, 2015 till December 31, 2015, then they can do so by sending a demand draft of ₹ 500 (five hundred only) in the name of *Chairman GATE*, payable at Kanpur and send to GATE Office, IIT Kanpur.

❖ 7. Frequently Asked Questions (FAQ)

➢ 7.1 Application Process

1. **How do I apply ONLINE?**
   Go to the link "How to apply?", read the instructions and apply using the link provided in the main page.

2. **Can I use one e-mail address to fill multiple application forms?**
   NO, one e-mail address can be used to submit only **one** application form.

3. **Why should I choose three examination cities?**
   Generally, you will be allotted a centre in the examination city of your first choice. Only in cases where it becomes difficult to accommodate you in the examination city of your first choice, your other two choices will be considered. A candidate is required to fill his/her primary as well as secondary choices, but should remember that because of operational constraints, the GATE committee reserves the right to add a new city or remove an existing one, and allot a city that may not be any of the choices of a candidate.

4. **My power/internet connection failed during the application process, what do I do?**
   If you have clicked on the "Save" button during the application process, the data you entered up to that point of time has been stored online. Simply login back to the GATE 2015 application website and continue the application process. Otherwise, you have to start the process afresh.

5. **You are asking only the SC/ST/PwD candidates to upload the category certificate. What about the OBC (non-creamy layer) candidates? Do they have to upload the category certificate too?**
   NO. Category certificate is required at this stage only to claim the concessional rate for the application fee. The category of the candidate has been captured for general information purpose only. The GATE scorecard does not indicate the category of the candidate, but displays the marks/score obtained by the candidate and the category wise cut-off. However, you have to produce the category certificate to the admitting institute at the time of admission to justify your claim of belonging to the respective category.

6. **How do I make the fee payment for GATE 2015 examination?**
   You can make the payment during the **ONLINE** application process by choosing the following option:

a) *Online Payment: Net Banking through the payment gateway.*

b) *e-challan facility of both SBI and Axis Bank*

7. **If I want the Online Payment (Net-banking) option, how should I complete the application process?**
After filling all the fields in the ONLINE application form, choose the Online Payment option and proceed for payment by following the instructions.

a) Your browser screen will re-direct you to the bank you choose. Login with your Internet Banking credentials and confirm the payment.

b) After confirming the payment, you will be re-directed back to the GATE 2015 application website where you would be required to fill in all the details.

c) At the end of this process, a PDF file will be generated with the following pages:

i. **Page 1:** Application form with the necessary details of the candidates, like full name, date of birth (DoB), scanned photograph, sex, category (GE/OBC/SC/ST), PwD (Y/N), full contact address, mobile number, email id, etc.

ii. **Page 2:** Bachelor degree certificate or certificate signed copy by the college principal (depending on your eligibility status).

iii. **Page 3**: The uploaded caste certificate.

iv. **Page 4**: The uploaded PwD certificate.

v. **Page 5:** Online payment details like your bank account number, bank name, transaction id, date and time of transaction, amount paid, etc.

d) Take a printout of the entire PDF file for your future reference/use.

8. **My power/internet connection failed during online payment. What do I do?**
When you can get back online, first check the status of your payment on the GATE application website.

a) If the payment was received by GATE, you can continue the process of printing the application form.

b) If the payment was not received by GATE, you have to start with the payment step again, to complete payment.

9. **My net banking account has been debited (money taken out) more than once. How do I get the money back?**
This can happen if your bank account was used more than once or you pressed refresh or back/forward button of your internet browser. Please check your bank account after 48 hours. Any unaccounted or excess money that was received on

behalf of GATE 2015 from this account will automatically be returned (credited) to the same bank account.

10. **My bank account has been debited (money taken out), but GATE Application website says that the payment has not been received. What do I do?**

    This happens because of some failure in internet transactions (including failure of internet connection at your end). As soon as possible, you MUST initiate a fresh payment process on the GATE application website, and make the payment again. The money that was debited (taken out) from your account in the first attempt, will be credited (put back) to your bank account within 72 hours. You will be charged only once. Any excess/unaccounted debits will be returned to you.

11. **If I want the Bank challan option, how should I complete the application process?**

    There is **NO** option of payment through bank challan.

12. **Do I have to send the print-out of the application form?**

    No.

13. **When and how will I know the status of my application?**

    You can check the status of your application by logging onto GOAPS website.

14. **After completing the ONLINE application process and generating a PDF file, will I be able to change my application data?**

    NO. After completing all the steps upto PDF application form generation in the ONLINE application process, you can only download the application form and **CANNOT** modify the data. Hence you need to be very careful while entering the data. You may also save a partially filled application and login in again at a later point in time to complete and submit the application, however it must be within the specified deadline.

15. **I have missed to take a print-out of my ONLINE application at the end of my application process. How will I get access to it?**

    You can login using GOAPS Enrolment ID and password and take a printout.

➢ 7.2 Admit Card

1. **When will I receive my admit card?**

   Admit Card can **ONLY** be downloaded from the zonal GATE websites from 17th December 2014. Admit Cards will **NOT** be sent by post.

2. **Is the Admit card alone sufficient to gain entry to the exam?**

   NO. Bring the Admit Card at the test center **along with** at least one original (not photocopied/scanned copy) and valid (not expired) photo identification, whose

details have been entered while filling the application. **ONLY** one of the following photo identifications is permitted: Driving license, Passport, PAN Card, Voter ID, Aadhaar UID, College ID, Employee Identification Card, or a Notarized Affidavit with Photo, Signature, Date of Birth and Residential Address. Photocopies of the identification document are not acceptable. Candidates will not be permitted to take the exam if the original and valid photo identification is not presented.

➢ 7.3 GATE 2015 Exam

1. **For how many GATE papers can I apply?**

   A candidate can apply for only **ONE** of the 22 papers listed in the GATE INFORMATION BROCHURE or GATE website. The choice of the appropriate paper is the responsibility of the candidate. Some guidelines in this respect are suggested below.

   1. The candidate is expected to appear in a paper appropriate to the discipline of his/her qualifying degree.
   2. 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

2. **After submission of application, am I permitted to change my GATE Examination Paper and Examination City?**

   Requests for change of GATE Examination paper after the submission of Application Form will not be considered. However, requests for change of examination city will be accepted till 21st November, 2014 with a fee of ₹400/-(four hundred only) to be paid in the form of a Demand Draft (DD) in favor of "Chairman GATE 2015", payable at Kanpur. Please send this DD to the GATE office, IIT Kanpur.

3. **Will I be provided with any white paper for rough work and calculations during the test?**

   A scribble pad will be provided to the candidate that can be used to do the rough work. The candidate has to return the scribble pad after the examination.

4. **Am I allowed to leave the examination hall during the test?**

   NO. Candidates will **NOT** be allowed to leave the examination hall for any reason during the test. Candidates are allowed to leave the computer laboratory where the exam will be conducted only after the closure of the test at the scheduled end of examination in a session.

5. **What items are not permitted to be brought with me inside the examination venue?**

   Electronic diary, mobile phone, and any such electronic gadgets, blank papers, clip boards and log-tables will not be allowed in the examination venue.

6. **Can I use a calculator during the examination?**

   NO. During the online GATE 2015 examination, all candidates will be provided with an online scientific calculator which has to be used to answer the questions.

7. **Will there be any arrangement at the test center for the safe keeping of my personal items such as my mobile phone?**

   NO. Such arrangements will not be possible at the test center.

❖ 8. Contact Us

GATE is jointly administered and conducted by the Indian Institute of Science and seven Indian Institutes of Technology. Table 8.1 gives the details of each Zonal Office. Each of the institutes administers a zone and caters to examination cities nearby to the institute. Candidates are assigned a zone at the time of application, based on the first city of choice. Candidates must note this zone number for contact purposes.

Candidates must use the GOAPS (GATE Online Application Processing System) to contact Zonal GATE offices, which will provide quicker and clearer information. The phone, fax or e-mail may be used only if someone is unable to get information even after going through FAQs.

Table 8.1: Contact details for Zonal GATE Offices zonal offices

Zone	Contact Address	Phone Number	FAX	e-mail Id
1	Chairman, GATE Indian Institute of Science Bangalore Bengaluru 560 012	080-2293 2392 080-2360 0902	080-2360 1227	gate@gate.iisc.ernet.in
2	Chairman, GATE Indian Institute of Technology Bombay, Powai, Mumbai 400 076	022-2576 7068 022-2572 4054	022-2572 3706	gateoffice@iitb.ac.in
3	Chairman, GATE Indian Institute of Technology Delhi, HauzKhas, New Delhi 110 016	011-2659 1749 011-2659 6137	011-2658 1579	chrgate@admin.iitd.ac.in
4	Chairman, GATE Indian Institute of Technology Guwahati, Guwahati 781 039	0361-258 2751	0361-258 2755	gate@iitg.ernet.in
5	Chairman, GATE Indian Institute of Technology Kanpur, Kanpur 208 016	0512-259 7412	0512-259 0932	gate@iitk.ac.in
6	Chairman, GATE Indian Institute of Technology Kharagpur, Kharagpur 721 302	03222-282091	03222-278243	gate@adm.iitkgp.ernet.in
7	Chairman, GATE Indian Institute of Technology Madras, Chennai 600 036	044-2257 8200	044-2257 8204	gate@iitm.ac.in
8	Chairman, GATE Indian Institute of Technology Roorkee, Roorkee 247 667	01332-284531	01332-285707	gate@iitr.ernet.in

❖ 9. Appendix A

➢ 9.1 Authorities Empowered to Issue Certificates (SC/ST)

- 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.
- Chief Presidency Magistrate/ Additional Chief Presidency Magistrate/ Presidency Magistrate
- Revenue Officer not below the rank of Tahsildar

- Sub-Divisional Officer of the area where the Candidate and/or her/his family normally resides
- Administrator/ Secretary to Administrator/ Development Officer (Lakshadweep Islands)

Certificate issued by any other official will not be accepted.

➢ 9.2 PwD (Person with Disabilities) Category:

In order to avail concession under the PwD category, the candidates should attach a recently obtained proper PwD certificate, which shall be required to be submitted to the admitting institution at the time of admission. The onus of verifying PwD certificate lies with the admitting institute. The GATE committee will not be responsible for any incorrect declaration of the PwD status of candidates.

❖ 10. Appendix B: Qualifying Disciplines

Table 10.1: Qualifying Disciplines for Eligibility Degrees

Discipline: Engineering/Technology	Discipline: Science
Aeronautical Engg./ Aerospace Engg.	Agricultural Science
Agricultural Engg.	Applied Electronics
Applied Mechanics	Applied Physics
Architecture	Biochemistry
Automobile Engg.	Bio-Sciences
Biochemical Engg.	Chemistry
Biomedical Engg.	Computer Applications
Biotechnology	Earth Sciences
Ceramic & Glass Technology	Electronics
Chemical Engg.	Engineering Physics
Chemical Technology	Geology/ Geophysics
Civil/Civil & Environmental/Structural Engg./ Construction Engg.	Industrial Chemistry
Computer Engg.,/Computer Science &Engg./Technology	Life Science/Veterinary/Animal Science
Control and Instrumentation	Life Sciences
Electrical Engg./ Electrical and Electronics Engg./Power Engineering	Life Sciences (Botany)
Electro-Chemical Engg.	Life Sciences (Zoology)
Electronics & Comm./Electronics Engg./Comm. Engg. /Telecommunication Engg.	Materials Science
Energy Engg.	Mathematics/Applied Mathematics
Environmental Engg.	Microbiology
Food Technology/Food Processing Engg.	Nano Science & Technology
Industrial Engg.	Nuclear Physics
Industrial Management	Operations Research
Information Science/Information Technology/Information and Communication Technology	Pharmaceutical Sciences/Pharmacy
Instrumentation/ Electronics/Control	Physics
Instrumentation & Process Control	Radio Physics
Manufacturing Engg.	Radio Physics & Electronics
Material Science and Engineering	Statistics
Mechanical Engg.	Textile Chemistry
Mechatronics	All other disciplines in Sciences
Medical Instrumentation	
Metallurgical Engg./ Industrial Metallurgy	
Mineral Engg./Mineral Dressing	
Mining Engg./Technology, Mining & Machinery	
Naval Architecture/Marine Engg.	
Oil Technology	
Paint Technology	
Petro-Chemical Engg.	
Petroleum Engg./Technology	
Planning	
Plastic Technology	
Polymer Technology/Science	
Production & Industrial Engg.	
Renewable Energy	
Rubber Technology	
Textile Engineering &Fibre Science	
All other disciplines in Engg./Technology	