PANJAB UNIVERSITY CHANDIGARH

(Established under the Panjab University Act VII of 1947
Enacted by the Government of India)

PH.D. -2025 ENTRANCE TEST TO BE HELD ON 14-09-2025 (Sunday)

Last date for submission of information on the website to generate Login ID and Password: 02-09-2025 (Tuesday)

Website: http://phdengineering.puchd.ac.in

FEE (Non-refundable):
General Category Rs. 2710/-
SC/ST/PwD Category Rs. 1355/-

PANJAB UNIVERSITY ANTHEM

तमसो मा ज्योतिर्गमय:	Tamso ma jyotirgamaya
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पंजाब विश्वविद्यालय	Panjab vishaw vidyalaya
तेरी शान – ओ – शौकत सदा रहे	Teri shaan-o-shauqat sada rahe
मन में तेरा आदर मान	Mann mein tera aadar maan
और मोहब्बत सदा रहे	Aur mohabbat sada rahe
पंजाब विश्वविद्यालय	Panjab vishaw vidyalaya
तेरी शान – ओ – शौकत सदा रहे	Teri shaan-o-shauqat sada rahe
तू है अपना भविष्य विधाता	Tu hai apna bhavishya vidhata
पंख बिना परवाज़ सिखाता	Pankh bina parwaaz sikhata
जीवन पुस्तक रोज़ पढ़ा कर	Jeevan pustak roz padha kar
सही गलत की समझ बढ़ाता	Sahi galat ki samajh badhata
जीवन पुस्तक रोज़ पढ़ा कर	Jeevan pustak roz padha kar
सही गलत की समझ बढ़ाता	Sahi galat ki samajh badhata
तेरी जय का शंख बजायें	Teri jai ka shankh bajayein
रौशन तारे बन जायें	Roshan tare ban jaayein
वखरी तेरी शोहरत	Vakhari teri shohrat
तेरी शोहरत सदा सदा रहे	Teri shohrat sada sada rahe
पंजाब विश्वविद्यालय	Panjab vishaw vidyalaya
तेरी शान – ओ – शौकत सदा रहे	Teri shaan-o-shauqat sada rahe
पंजाब विश्वविद्यालय	Panjab vishaw vidyalaya
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तमसो मा ज्योतिर्गमय:	Tamso ma jyotirgamaya
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IMPORTANT DATES / INFORMATION FOR ENTRANCE TEST-2025

Date of availability of Ph.D. Prospectus and Online Entrance Test Form on the website of Panjab University, Chandigarh	25-07-2025 (Friday)
Last date for submission of information on the website to generate the Login ID and Password	02-09-2025 (Tuesday)
Last date for deposit of fee through Online Mode	04-09-2025 (Thursday)
Last date for uploading of photograph, signature with rest of the information on the website https://phdengineering.puchd.ac.in	06-09-2025 (Saturday)
Last date for submission of printout of form along with required documents for claiming the concession of Entrance Test Fee for SC/ST/PwD/PU Employee to Assistant Registrar, CET Cell, Aruna Ranjit Chandra Hall, Panjab University, Chandigarh - 160014 by registered post / speed post or by hand	08-09-2025 (Monday)
Final date by which Roll No. Will be available online Roll No. And Centre of Examination will be generated and Roll No. Slip required to be downloaded from the website by the candidate using their own Login and Password. **There will be no physical communication for this purpose.**	09-09-2025 (Tuesday)
Last date for Candidates who have not completed their form but have paid requisite fee, can complete their form (10:00 a.m. to 4:00 p.m.) by paying late fee of Rs. 500/-	11-09-2025 (Thursday)
Candidates who have not completed their form but have paid their requisite fee, can complete their form by paying (from 10:00 a.m. to 4:00 p.m.) late fee of Rs. 500/-	11-09-2025 (Thursday)
Date of Holding Entrance Test	**14-09-20205 (Sunday)**
Uploading of Answer Key and inviting Objections (through e-mail to arcet@pu.ac.in)	15-09-2025 (Monday)
Last day of submission of objections to the Answer key	17-09-2025 (Wednesday)
Uploading of the response to the Objections and inviting Cross-objections (through e-mail only)	24-09-2025 (Wednesday)
Last day of submission of Cross-objections to the Answer key	26-09-2025 (Friday)
Date of declaration of result	15-10-2025 (Wednesday) The result will be posted on the P.U. website https://results.puchd.ac.in and the same could be downloaded. No separate result cards will be issued to the candidates by the office.
Centre for Entrance Test	Chandigarh Only

DATE SHEET

Date & Day	Paper	Time
14-09-2025 (Sunday)	**Paper-I (Objective type)**	**10.00 a.m. – 11.00 a.m.**
	Paper-II (Objective type)	**11.30 a.m. – 12.30 p.m.**

IMPORTANT NOTES

1. The Fee for Ph.D. Entrance Test is Rs. 2710/- (Rs. 1355/- for SC/ST/PwD). The fee for the Entrance Test, once paid, shall not be refunded.
2. Class B/C Regular Employee of PU must send the copy of printout of their Entrance Test Form along with Performa for claiming 50% concession to P.U. Regular Employees ("B" and "C" Class) duly signed by Head/Chairperson to **Assistant Registrar, CET Cell, Aruna Ranjit Chandra Hall, Panjab University, Chandigarh-160014** by registered post/speed post or by hand on or before **08-09-2025 (Monday)** upto 4:00 p.m.
3. Only the candidates, who have passed or are appearing in the qualifying examination for a particular Course can apply for the Entrance Test.
4. The Syllabus for Ph.D. Entrance Examination will be as prescribed for Master's Degree or equivalent classes of Panjab University in the relevant subject.
5. **Special arrangements for amanuensis (writer of Answer):**
   A candidate may be allowed help of an amanuensis (writer) if he/she is:

   (i) Blind
   OR
   (ii) Permanently disabled from writing with his/her own hand.
   (iii) Temporarily disabled from writing on account of fracture of the right or left arm, forearm or dislocation of a shoulder elbow or wrist etc. The candidate shall produce a certificate from a Professor of the speciality concerned of a Medical College and where there is no Medical College, from the Chief Medical Officer of the District concerned to the effect that the candidate is unable to write his/her Answer-books because of the temporary disablement.
6. The PwD candidate/s who wants to appear with his/her own scribe must contact Assistant Registrar, CET Cell one week prior of the entrance test.
7. 20 minutes extra per hour would be given to the visually handicapped / PwD candidates for each paper.
8. Candidates securing equal marks shall be bracketed together. Their **inter-se** merit will be determined by the Institution in accordance with the following criteria:
   (i) A candidate getting higher percentage of marks in the qualifying examination shall rank higher in order of merit.
   (ii) That if the marks in qualifying examination are also the same then the candidates obtaining more marks in the immediate lower examination, shall rank higher in order of merit.
   (iii) That if two or more candidates secure equal marks in (i) & (ii) above, candidate senior in age shall rank higher in the order of merit.
9. The result of the Entrance Test will be available at http://results.puchd.ac.in. **No separate Result Cards will be issued.**
10. **Candidates can deposit their Admission Form for Ph.D. only after the declaration of the result of the Ph.D. Entrance Test-2025.**

PANJAB UNIVERSITY, CHANDIGARH

GENERAL INFORMATION

The Panjab University, Chandigarh will hold an Entrance Test for enrolment to Ph.D. in the Faculty of Engineering.

Faculty of Engineering

Sr. No.	Name of the Department / College	Subject	No. of slots for Ph.D. (subject to change)	
1	University Institute of Engineering and Technology	Biotechnology	04	03(Gen), 01(SC)
		Computer Science & Engineering	46	32(Gen),07(SC), 03(ST), 2(BC), 2(PwD)
		Electronics & Communication Engineering	25	17(Gen),04(SC), 02(ST), 1(BC), 1(PwD)
		Electrical & Electronics Engineering	39	26(Gen),06(SC), 03(ST), 2(BC), 2(PwD)
		Information Technology	35	23(Gen),05(SC), 03(ST), 2(BC), 2(PwD)
		Mechanical Engineering	55	37(Gen),08(SC), 04(ST), 3(BC), 3(PwD)
	TOTAL	204 (138 Gen + 31 SC + 15 ST + 10 BC + 10 PwD)		
2.	Dr. S.S.B. UICET, P.U., Chandigarh	Chemical Engineering	09 (Gen.); 02 (SC); 01 (ST); 01 (BC); 01 (PwD)	
		Food Technology	05 (Gen.); 01 (SC)	
		Industrial Chemistry	04 (Gen.); 01 (SC)	
3	Chandigarh College of Engineering & Technology, Sector 26, Chandigarh	Computer Science Engineering	24 (Gen.); 06 (SC); 03 (ST); 02 (BC); 02 (PwD)	
		Mechanical Engineering	13 (Gen.); 03 (SC); 01 (ST); 01 (BC); 01 (PwD)	
		Civil Engineering	05 (Gen.); 01 (SC); 01 (ST)	
		Electronics & Communication Engineering	34 (Gen.); 07 (SC); 04 (ST); 02 (BC); 02 (PwD)	

IMPORTANT NOTE:
The seats available will be subject to reservation as per Panjab University Rules and Regulations.

PROCEDURE FOR ADMISSION TO Ph.D. PROGRAMME

For admission to these courses the candidates have to qualify Ph.D. entrance test conducted by the Panjab University, Chandigarh. Procedure for admission to Ph.D. Programme will be followed as per the Guidelines approved by the Panjab University and circulated vide letter No. ST.4313-4512 dated 01-06-2023.

ELIGIBILITY FOR TEST OF FACULTY OF ENGINEERING

Master's degree in Engineering or Technology in the subjects of Computer Science & Engineering / Electronics & Communication / Electrical & Electronics / Information Technology / Mechanical / Biotechnology/ Materials / Microelectronics or an Allied subject approved by AICTE. For Ph.D. in the Subjects related to applied Science, Master's degree in Science in (Physics/ Chemistry / Mathematics) or Allied subjects (The candidates will be enrolled in Faculty of Science).

Any candidate who has passed the Master's examination in the concerned subject with a score of not less than 55% (50% for SC/ST/BC/PwD Category) marks in aggregate or have appeared in the final year examination of Master's degree in the subject concerned from Panjab University, Chandigarh or from any other University (approved by the appropriate Academic Bodies of P.U.) shall be eligible to appear for the Ph.D. Entrance Test.

The students taking admission in Ph.D. in Faculty of Engineering after B.E./B.Tech., the Credit Requirement for Ph.D. coursework should be of total 20 credits. This include 12 credits as per current on-going course-work regulations and remaining 8 credits include 4 credits for one core department subject and 4 credits for one open subject from the core/allied branches across Faculty of Engineering.

These Research Scholars (students taking admission in Ph.D. in Faculty of Engineering after B.E./B.Tech.) be allowed to submit Ph.D. synopsis within 2 years of the regulation in Ph.D. Further extension of upto 6 months (total 2 ½ years) for submission of synopsis / approval of candidacy) may be granted as per Panjab University rules.

For Chemical/ Food Technology / Industrial Chemistry

Any candidate who has passed the Master's examination in the concerned subject with a score of not less than 55% (50% for SC/ST/BC/PwD Category) marks in aggregate, or have appeared in the final year examination of Master's degree in the subject concerned from Panjab University, Chandigarh or from any other University (approved by the appropriate Academic Bodies of P.U.), shall be eligible to appear for the Ph.D. Entrance Test.

EXEMPTION FROM ENTRANCE TEST FOR ENROLMENT To Ph.D. AS PER THE CIRCULAR NO. ST. 4313-4512 DATED 01-06-2023

Panjab University shall admit Ph.D. scholars through Entrance Test conducted at the level of the University.

i. However, exemption from entrance test will be given to those who have already cleared any of the National Test for the eligibility of lectureship like UGC/ CSIR NET including JRF, GATE, CEED, GPAT, ICMR, ICAR, or any other prestigious test for National level scholarship / fellowship conducted by Govt. of India.
ii. Direct awardees of National / International fellowship for pursuing Ph.D. and working regular teachers of Panjab University and its affiliated Colleges are exempted from the entrance test.

iii. The GATE/ GPAT qualified candidates or any other national level test qualified candidates meant for admission to Ph.D. be considered for the enrollment in Ph.D. Programme.
iv. **Ph.D. Entrance Test of Panjab University for admission to Ph.D. shall be valid for 3 years.**
v. The Entrance Test syllabus shall consist of 50% of research methodology and 50% shall be subject specific.
vi. Students who have secured 50% marks in the entrance test are eligible to be called for the interview.
vii. A relaxation of 5% marks will be allowed in the entrance examination for the candidates belonging to SC/ST/OBC/differently-abled category, Economically Weaker Section (EWS), and other categories of candidates as per the decision of the UGC from time to time.
viii. Panjab University may decided the number of eligible students to be called for an interview based on the number of Ph.D. seats available in the respective departments/ approved research centres.
ix. Provided that for the selection of candidates a weightage of 70% for the Academic Performance Index and 30% for the performance in the interview / viva-voce shall be given.
x. **With regard to admission in Ph.D. for foreign students, the following guidelines shall be followed:-**
    (a) International/ Foreign students who are being sponsored by the government body such as the ICCR or MHRD or a government agency of their own country, will be given direct admission to Ph.D. subject to the approval of the concerned department or centre.
    (b) International / Foreign students who have been studying in India and are present in India at the time of the Ph.D. CET will have to sit for the test and clear it in order to be considered for enrolment.
    (c) The International / Foreign students who are not present in India at the time of the Panjab University Ph.D. CET will need to achieve at least band 5 in IELTS Academic or 60 in TOEFL or 150-154 in GRE or 600 in GMAT. At the time of filling the enrolment form the candidate must attach the score in any one of the above tests. However, all such candidates will have to qualify in the interview.

SCHEME OF TEST

Paper-1 Research Methodology (Objective type)

50 Marks, Time Allowed: 60 Minutes

This paper will contain 50 Multiple Choice Questions of 1 mark each divided in two Sections

- Section A : 30 Questions
- Section B: 20 Questions

Paper-2 Engineering Discipline (Objective type):

50 Marks, Time Allowed: 60 Minutes

This paper will contain 50 Multiple Choice Questions of 1 mark each of Engineering Discipline. Candidate may choose any one of the following Engineering Disciplines:

S. No.	Name of Engineering Discipline
1	Biotechnology Engineering
2	Civil Engineering
3	Chemical Engineering
4	Computer Science & Engineering/ Information Technology
5	Electronics and Communication Engineering
6	Electrical and Electronics Engineering
7	Food Technology
8	Industrial Chemistry
9	Mechanical Engineering

RESULT

Initial evaluation will be of Paper-I (Objective Type). Only if a candidate obtains 40% (35% for SC/ST/BC/PwD) marks or more only then his/ her paper II will be evaluated.

However, the total qualifying marks for Paper I and II would be 50%. (Syndicate Para 2 dated 08-03-2020).

Result of Ph.D. entrance test will be available on Panjab University website results.puchd.ac.in

INTERVIEW

Panjab University shall conduct entrance examination as a qualifying examination for admission to Ph.D. once a year (with exemption of test to categories mentioned in Page No. 7 & 8 of the Prospectus). However, to facilitate admission of candidates before the expiry of the validity of entrance examination / JRF offer letter, the application for admission to Ph.D. shall be accepted throughout the year. All accepted applications shall be processed for admission in three cycles in a year (i.e. in the months of January, May and September). However, in case of research fellows employed under any state/ central/ international research projects, their applications for admission to Ph.D. shall be processed throughout the year provided they fulfill eligibility guidelines. In each admission cycle a fresh merit list shall be prepared.

FELLOWSHIP: A few University fellowships are available for Ph.D. research. If successful candidates wish to be considered for the University fellowship they should report to their respective departments.

RESERVATION PROCEDURE

i. Adhere to the National / State-level reservation policy, as applicable taking cumulative number of seats in each admission cycle during over a period of one year.
ii. The reservation of seats of SC/ST/BC/PWD candidates will be department-wise and L-shaped roster would be followed, i.e., if the number of seats in a given admission cycle is less than 7, then the reservation will be given in the next admission cycle when the 7th seat (counting seats of both the admission cycles) becomes available. Similarly, if cumulative number of seats in first two cycles is less than 7, then the reservation will be given in third cycle when 7th seat (counting seats of all three admission cycles) becomes available. At the end of year (i.e. all three cycles), if number of seats is less than 7, then the reservation

will be given in the next year when the 7th seat (counting seats of last three and 1st cycle of the current years) becomes available.

iii. The specialisation within the subject for giving reservation will be decided by the department. Reservation policy is to be followed for Ph.D. scholars working as Project Fellows in various projects also. Every Project In-charge / Principal Investigator would be enjoined upon to ensure that nth project fellow recruited under him / her is from the reserved category enlisted for reservation at the nth position, e.g. every 7th project fellow is for SC category and so on.

IMPORTANT NOTE: ANY MODIFICATION REGARDING PH.D. -2025 ENTRANCE TEST WILL BE UPLOADED ON THE WEBSITE https://phdengineering.puchd.ac.in LATER ON.

GENERAL RULES

1. Qualifying the Entrance Test shall not, ipso facto, entitle a candidate to get enrolment in the Department concerned where he / she intends to seek enrolment. This will be followed by mandatory interview. The selection would be solely based on the performance of the candidates in the interview. It will be the responsibility of the candidate to ensure his/her eligibility and fulfillment of such other conditions as may be prescribed for enrolment in the Rules and Regulations of the University. The enrolment will be subject to the availability of seats and Experts for Guidance / Supervision in the Area of Research to be chosen by the candidate and the candidate is required to verify these facts from the concerned Department before applying for the Test.

2. The Entrance Test will be held on **14-09-2025 (Sunday)** at **Chandigarh** only.

3. Once the candidate has submitted the information on the website, any change in the Form/information, including category once marked, shall not be allowed.

4. A candidate desirous of taking the Entrance Test should submit his/her fee through online mode by **04-09-2025 (Thursday).**

5. Last date for completing the Entrance Form including uploading of photograph, signature, with rest of the information on the website is **06-09-2025 (Saturday).**

6. The fee for the Entrance Test once paid shall not be refunded / transferred / adjusted.

7. The candidates shall be required to hand over their OMR Answer-Sheets and the Question Papers / Booklets in full to the Centre Superintendent even if they have not attempted any question. No page/part of the Question Paper/Answer Sheet is to be removed / torn/taken out of the Examination Centre under any circumstances, failing which the candidates shall be disqualified from the entire test.
8. The use of calculator is not allowed in any subject/paper, except in Paper-II of Faculty of Engineering. But it should not be Programmable Calculator.

9. The University will provide the logarithmic table. Borrowing of log table or other material from any other person/ candidate is not allowed.

10. **No candidate shall be allowed to leave the examination hall/room before the expiry of the time allowed for the respective examination.**

11. For rough work, only the Sheets marked 'Rough Work' at the end of the question booklet/script should be used. No rough work should be done on the OMR Answer Sheet under any circumstances.

12. Any candidate who carries any telecommunication equipment such as pager, cellular phone, wireless set, Bluetooth device, etc. inside the examination hall shall be expelled from the examination hall & disqualified.

13. If any candidate who submits multiple Online Entrance Test Forms for the same Course his/her candidature shall be considered only on the basis of one Form.

14. The candidates must bring their own stationary items such as **Black Gel Pen. Borrowing of material inside the Test Centre is strictly prohibited.**

15. **There shall be no negative marking.**

16. If a candidate wishes to verify her/his result, s/he will be provided a photocopy of her/his OMR Answer sheet only on payment of Rs.10,000/- ***within 10 days after the declaration of the Entrance Test result***. The University office would complete the whole procedure of verification within three working days. In case, a discrepancy is found in the result of the candidate, it would accordingly be revised and the verification fee will be refunded.

17. The candidates shall be required to ensure that the answers to the questions are attempted on the specifically prescribed OMR answer sheet only, as per the rules/ norms stated in the respective OMR Answer Sheets. No answer attempted on the question booklet will be considered for evaluation. Only those questions answered on the OMR sheet shall be taken into account.

18. Candidates are not allowed to carry eatables, drinks etc. into the Test Centre. Smoking inside and around the Centre is not permitted.

19. Any candidate who creates disturbance of any kind during examination or otherwise misbehaves in or around the examination hall or refuses to obey the Superintendent/Deputy Superintendent/Assistant Superintendent/any other official on examination duty or changes his/her seat with any other candidate or occupies any seat, other than the one allotted to him/her shall be expelled from the examination hall.
    ("Expulsion" for this purpose would mean cancellation of candidature)

20. Any candidate having in his possession or accessible to him/her papers/books or notes which may possibly be of any assistance to him /her or is found giving or receiving assistance, or copying from any paper/book or note or from anywhere else or allowing any other candidate to copy from his/her OMR Answer book or found writing on any other paper question set in the question paper during examination, or using or attempting to use any other unfair means, or indulging in any kind of misconduct, shall be expelled from the examination hall.
    ("Expulsion" for this purpose would mean cancellation of candidature)

21. If any OMR Answer Sheet of a candidate shows or if it is otherwise established that he/she has received or attempted to receive help from any source in any manner or has given help or attempted to give help to any other candidate in any manner, the relevant Answer-Sheets shall be cancelled. The decision of the Controller of Examinations, Panjab University, Chandigarh, in this regard shall be final.

22. **If a candidate writes his/her name or puts any kind of identification mark or discloses his/her identity by any method whatsoever on the cover or anywhere else in the Question Booklet/OMR Answer Sheets, the same shall be treated as cancelled. The decision of the Controller of Examinations, Panjab University, Chandigarh, in this regard shall be final.**

23. Any person who impersonates a candidate, shall be disqualified from appearing in any Panjab University examination for a period of **five years** including this Entrance Test, if that person is a student on the rolls of a recognized College or University, he/she shall be declared as a person not fit and proper to be admitted to any examination of the Panjab University for a period of **five years**. The case, if necessary, shall also be reported to the police for any further action in the matter.

24. If it is found that a candidate has knowingly or willfully concealed or suppressed any information/fact which renders him/her ineligible to take the Entrance Test,

his/her result of the Test as also admission/enrolment to a Institution/Department/Centre of the University, if granted, shall stand cancelled and he/she shall have no claim whatsoever against the Institution/ Department/ Centre concerned and the case, if necessary shall be reported to the police.

25. If a dispute or controversy of any kind arises before, during or after conduct of the Entrance Test, the decision of the Controller of Examinations, Panjab University, in all such cases, shall be final.

26. **The candidates shall be admitted to the Test only on the production of the Admit Card at the Test Centre. No candidate shall be allowed to take the test without the Admit Card under any circumstances. The candidates must retain the Admit Card with them till the enrolment process is over and must produce the same at the time of enrolment.**

27. The Admit Cards will be issued to the candidates only provisionally, at their sole risk and responsibility subject to the final confirmation of their eligibility at the time of admission / enrolment. It is further clarified that the candidates shall be taking the test at their own risk and responsibility as far as their eligibility is concerned and the University shall, in no way, be responsible if they are found to be ineligible, later, leading to cancellation of their result or any other consequence(s) emanating from the same.

28. The final date by which Roll No. will be available online is **09-09-2025 (Tuesday)**. Admit Card required to be downloaded from the website by the candidate using their own Login and Password. **There will be no physical communication for this purpose.**

29. On **15-09-2025**, the Question Papers and Answer Keys will be put on the University website http://exams.puchd.ac.in/show-noticeboard.php. The candidates can file their objections regarding discrepancies and accuracy of the Key by e-mail to arcet@pu.ac.in latest by **17-09-2025**. Objections received will be published on the website and cross objections will also be invited within a certain timeframe as mentioned in the Schedule for Entrance Test at Page 4. The valid concerns thus expressed will be given due consideration while evaluation.

30. The following functionaries may be contacted for extremely urgent enquiry, if any, only on working hours i.e. from Monday to Friday (from 10:00 a.m. to 4:00 p.m.).

1. Assistant Registrar (C.E.T.)	**0172 – 2534829**
2. Superintendent (C.E.T.)	**0172-2534829, 9814666346**
3. Dealing official (C.E.T.)	**9872812339**
3. Controller of Examinations	**0172 – 2534811**
4. Main Enquiry Office	**0172 – 2534818, 2534819, 2534866, 18001802065**

PU Ph.D. Entrance Examination
Faculty of Engineering

Paper 1: Research Methodology

(COMMON TO ALL CANDIDATES)

SECTION -A

Note: 30 Objective type Questions of 1 mark each common to all branches of Engineering.

Nature and Purpose of Research: Meaning of research, aim, Nature and scope of research, Prerequisites of research, Types of research: Exploratory, Descriptive and Experimental.
Research Problem: Types of research problems, Characteristics of a good research problem, Hypothesis: Meaning and types of hypothesis, Research proposal or synopsis.
Research Methods: Qualitative and Quantitative
Review of Literature: Purpose of the review, Identification of the literature, organizing the literature.
Data Collection and Analysis: Types of data, Methods of data collection, Sample and Population, Sampling Techniques, Characteristics of a good sample, Tools of Data Collection: Observation method, Interview, Questionnaire, various rating scales, Characteristics of good research tools.
Descriptive Statistics: Tabulation, Organization, and Tabulation and Graphical Representation of Quantitative data, Measures of Central Tendencies: Mean, Median, Mode Measures of Variability: Range, Quartile Deviation, Standard Deviation, and Coefficient of variation. Normal Probability Distribution: Properties of normal probability curve, Skewness and Kurtosis, Data analysis with Statistical Packages (MS-Excel, SPSS), Hypothesis Testing, Generalization and Interpretation.
Research Report: Structure and Components of Research Report, Types of Report, Characteristics of Good Research Report, Bibliographical Entries, Research Ethics.

SECTION B:

Note: 20 Objective type Questions of 1 mark each common to all branches of Engineering.

Linear Algebra: Matrices and determinants; Systems of linear equations; Eigen values and Eigen vectors.
Calculus: Limits, continuity and differentiability; Partial derivatives, maxima and minima; Sequences and series; Test for convergence.
Differential Equations: Linear and nonlinear first order ODE's, higher order ODE's with constant coefficients; Cauchy's and Legendre's equations; Laplace transforms.
Fourier Series: Euler's formulae, conditions for Fourier expansion, points of discontinuity, odd and even functions, half range series.
Partial Differential Equations: Linear and nonlinear first order PDE's, Charpit's method, homogeneous linear PDE's with constant coefficients, complimentary functions and particular integral.

Paper-2

This paper will contain 50 Multiple Choice Questions of 1 mark each of Engineering Discipline. Candidate may choose any one of the following Engineering Disciplines:

S. No.	Name of Engineering Discipline
1	Biotechnology Engineering
2	Civil Engineering
3	Chemical Engineering
4	Computer Science & Engineering/ Information Technology
5	Electronics and Communication Engineering
6	Electrical and Electronics Engineering
7	Food Technology
8	Industrial Chemistry
9	Mechanical Engineering

Biotechnology Engineering

General Biology

Biochemistry: Biomolecules - structure and function; Biological membranes - structure, membrane channels and pumps, molecular motors, action potential and transport processes; Basic concepts and regulation of metabolism of carbohydrates, lipids, amino acids and nucleic acids; Photosynthesis, respiration and electron transport chain. Enzymes - Classification, catalytic and regulatory strategies; Enzyme kinetics - Michaelis-Menten equation; Enzyme inhibition - competitive, non-competitive and uncompetitive inhibition.
Microbiology: Bacterial classification and diversity; Microbial Ecology - microbes in marine, fresh water and terrestrial ecosystems; Microbial interactions; Viruses - structure and classification; Methods in microbiology; Microbial growth and nutrition; Nitrogen fixation; Microbial diseases and host-pathogen interactions; Antibiotics and antimicrobial resistance.
Immunology: Innate and adaptive immunity, humoral and cell mediated immunity; Antibody structure and function; Molecular basis of antibody diversity; T cell and B cell development; Antigen-antibody reaction; Complement; Primary and secondary lymphoid organs; Major histocompatibility complex (MHC); Antigen processing and presentation; Polyclonal and monoclonal antibody; Regulation of immune response; Immune tolerance; Hypersensitivity; Autoimmunity; Graft versus host reaction; Immunization and vaccines.

Genetics, Cellular and Molecular Biology

Genetics and Evolutionary Biology: Mendelian inheritance; Gene interaction; Complementation; Linkage, recombination and chromosome mapping; Extra chromosomal inheritance; Microbial genetics - transformation, transduction and conjugation; Horizontal gene transfer and transposable elements; Chromosomal variation; Genetic disorders; Population genetics; Epigenetics; Selection and inheritance; Adaptive and neutral evolution; Genetic drift; Species and speciation.
Cell Biology: Prokaryotic and eukaryotic cell structure; Cell cycle and cell growth control; Cell- cell communication; Cell signalling and signal transduction; Post-translational modifications; Protein trafficking; Cell death and autophagy; Extra-cellular matrix.
Molecular Biology: Molecular structure of genes and chromosomes; Mutations and mutagenesis; Regulation of gene expression; Nucleic acid - replication, transcription, splicing, translation and their regulatory mechanisms; Non-coding and micro RNA; RNA interference; DNA damage and repair.

Fundamentals of Biological Engineering

Engineering Principles Applied to Biological Systems: Material and energy balances for reactive and non-reactive systems; Recycle, bypass and purge processes; Stoichiometry of growth and product formation; Degree of reduction, electron balance and theoretical oxygen demand.

Classical Thermodynamics and Bioenergetics: Laws of thermodynamics; Solution thermodynamics; Phase equilibria, reaction equilibria; Ligand binding; Membrane potential; Energetics of metabolic pathways, oxidation and reduction reactions.
Transport Processes: Newtonian and non-Newtonian fluids, fluid flow - laminar and turbulent; Mixing in bioreactors, mixing time; Molecular diffusion and film theory; Oxygen transfer and uptake in bioreactor, k_La and its measurement; Conductive and convective heat transfer, LMTD, overall heat transfer coefficient; Heat exchangers.

Bioprocess Engineering and Process Biotechnology

Bioreaction Engineering: Rate law, zero and first order kinetics; Ideal reactors - batch, mixed flow and plug flow; Enzyme immobilization, diffusion effects - Thiele modulus, effectiveness factor, Damkoehler number; Kinetics of cell growth, substrate utilization and product formation; Structured and unstructured models; Batch, fed-batch and continuous processes; Microbial and enzyme reactors; Optimization and scale up.
Upstream and Downstream Processing: Media formulation and optimization; Sterilization of air and media; Filtration - membrane filtration, ultra filtration; Centrifugation - high speed and ultra; Cell disruption; Principles of chromatography - ion exchange, gel filtration, hydrophobic interaction, affinity, GC, HPLC and FPLC; Extraction, adsorption and drying.
Instrumentation and Process Control: Pressure, temperature and flow measurement devices; Valves; First order and second order systems; Feedback and feed forward control; Types of controllers – proportional, derivative and integral control, tuning of controllers.

Plant, Animal and Microbial Biotechnology

Plants: Totipotency; Regeneration of plants; Plant growth regulators and elicitors; Tissue culture and cell suspension culture system - methodology, kinetics of growth and nutrient optimization; Production of secondary metabolites; Hairy root culture; Plant products of industrial importance; Artificial seeds; Somaclonal variation; Protoplast, protoplast fusion - somatic hybrid and cybrid; Transgenic plants - direct and indirect methods of gene transfer techniques; Selection marker and reporter gene; Plastid transformation.

Animals: Culture media composition and growth conditions; Animal cell and tissue preservation; Anchorage and non-anchorage dependent cell culture; Kinetics of cell growth; Micro & macro- carrier culture; Hybridoma technology; Stem cell technology; Animal cloning; Transgenic animals; Knock-out and knock-in animals.

Microbes: Production of biomass and primary/secondary metabolites - Biofuels, bioplastics, industrial enzymes, antibiotics; Large scale production and purification of recombinant proteins and metabolites; Clinical-, food- and industrial- microbiology; Screening strategies for new products.

Recombinant DNA technology and Other Tools in Biotechnology

Recombinant DNA technology: Restriction and modification enzymes; Vectors - plasmids, bacteriophage and other viral vectors, cosmids, Ti plasmid, bacterial and yeast artificial chromosomes; Expression vectors; cDNA and genomic DNA library; Gene isolation and cloning, strategies for production of recombinant proteins; Transposons and gene targeting.

Molecular tools: Polymerase chain reaction; DNA/RNA labelling and sequencing; Southern and northern blotting; In-situ hybridization; DNA fingerprinting, RAPD, RFLP; Site-directed mutagenesis; Gene transfer technologies; CRISPR-Cas; Biosensing and biosensors.

Analytical tools: Principles of microscopy - light, electron, fluorescent and confocal; Principles of spectroscopy - UV, visible, CD, IR, fluorescence, FT-IR, MS, NMR; Electrophoresis; Micro- arrays; Enzymatic assays; Immunoassays - ELISA, RIA, immunohistochemistry; immunoblotting; Flow cytometry; Whole genome and ChIP sequencing.

Computational tools: Bioinformatics resources and search tools; Sequence and structure databases; Sequence analysis - sequence file formats, scoring matrices, alignment, phylogeny; Genomics, proteomics, metabolomics; Gene prediction; Functional annotation; Secondary structure and 3D structure prediction; Knowledge discovery in biochemical databases; Metagenomics; Metabolic engineering and systems biology.

Civil Engineering

Structural Engineering

Engineering Mechanics: System of forces, free-body diagrams, equilibrium equations; Internal forces in structures; Frictions and its applications; Centre of mass; Free Vibrations of undamped SDOF system.

Solid Mechanics: Bending moment and shear force in statically determinate beams; Simple stress and strain relationships; Simple bending theory, flexural and shear stresses, shear centre; Uniform torsion, Transformation of stress; buckling of column, combined and direct bending stresses.

Structural Analysis: Statically determinate and indeterminate structures by force/ energy methods; Method of superposition; Analysis of trusses, arches, beams, cables and frames; Displacement methods: Slope deflection and moment distribution methods; Influence lines; Stiffness and flexibility methods of structural analysis.

Construction Materials and Management: Construction Materials: Structural Steel – Composition, material properties and behaviour; Concrete - Constituents, mix design, short-term and long-term properties. Construction Management: Types of construction projects; Project planning and network analysis - PERT and CPM; Cost estimation.

Concrete Structures: Working stress and Limit state design concepts; Design of beams, slabs, columns; Bond and development length; Prestressed concrete beams.

Steel Structures: Working stress and Limit state design concepts; Design of tension and compression members, beams and beam- columns, column bases; Connections - simple and eccentric, beam-column connections, plate girders and trusses; Concept of plastic analysis -beams and frames.

Geotechnical Engineering

Soil Mechanics: Three-phase system and phase relationships, index properties; Unified and Indian standard soil classification system; Permeability - one dimensional flow, Seepage through soils – two - dimensional flow, flow nets, uplift pressure, piping, capillarity, seepage force; Principle of effective stress and quicksand condition; Compaction of soils; One- dimensional consolidation, time rate of consolidation; Shear Strength, Mohr's circle, effective and total shear strength parameters, Stress-Strain characteristics of clays and sand; Stress paths.

Foundation Engineering: Sub-surface investigations - Drilling bore holes, sampling, plate load test, standard penetration and cone penetration tests; Earth pressure theories - Rankine and Coulomb; Stability of slopes – Finite and infinite slopes, Bishop's method; Stress distribution in soils – Boussinesq's theory; Pressure bulbs, Shallow foundations – Terzaghi's and Meyerhoff's bearing capacity theories, effect of water table; Combined footing and raft foundation; Contact pressure; Settlement analysis in sands and clays; Deep foundations – dynamic and static formulae, Axial load capacity of piles in sands and clays, pile load test, pile under lateral loading, pile group efficiency, negative skin friction.

Water Resources Engineering

Fluid Mechanics: Properties of fluids, fluid statics; Continuity, momentum and energy equations and their applications; Potential flow, Laminar and turbulent flow; Flow in pipes, pipe networks; Concept of boundary layer and its growth; Concept of lift and drag.

Hydraulics: Forces on immersed bodies; Flow measurement in channels and pipes; Dimensional analysis and hydraulic similitude; Channel Hydraulics - Energy-depth relationships, specific energy, critical flow, hydraulic jump, uniform flow, gradually varied flow and water surface profiles.

Hydrology: Hydrologic cycle, precipitation, evaporation, evapo-transpiration, watershed, infiltration, unit hydrographs, hydrograph analysis, reservoir capacity, flood estimation and routing, surface run-off models, ground water hydrology - steady state well hydraulics and aquifers; Application of Darcy's Law.

Irrigation: Types of irrigation systems and methods; Crop water requirements - Duty, delta, evapo- transpiration; Gravity Dams and Spillways; Lined and unlined canals, Design of weirs on permeable foundation; cross drainage structures.

Environmental Engineering

Water and Waste Water Quality and Treatment: Basics of water quality standards – Physical, chemical and biological parameters; Water quality index; Unit processes and operations; Water requirement; Water distribution system; Drinking water treatment.

Sewerage system design, quantity of domestic wastewater, primary and secondary treatment. Effluent discharge standards; Sludge disposal; Reuse of treated sewage for different applications.

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

Transportation Engineering

Transportation Infrastructure: Geometric design of highways - cross-sectional elements, sight distances, horizontal and vertical alignments.

Geometric design of railway Track – Speed and Cant.

Concept of airport runway length, calculations and corrections; taxiway and exit taxiway design.

Highway Pavements: Highway materials - desirable properties and tests; Desirable properties of bituminous paving mixes; Design factors for flexible and rigid pavements; Design of flexible and rigid pavement using IRC codes.

Traffic Engineering: Traffic studies on flow and speed, peak hour factor, accident study, statistical analysis of traffic data; Microscopic and macroscopic parameters of traffic flow, fundamental relationships; Traffic signs; Signal design by Webster's method; Types of intersections; Highway capacity.

Geomatics Engineering

Principles of surveying; Errors and their adjustment; Maps - scale, coordinate system; Distance and angle measurement - Levelling and trigonometric levelling; Traversing and triangulation survey; Total station; Horizontal and vertical curves. Photogrammetry and Remote Sensing - Scale, flying height; Basics of remote sensing and GIS.

Chemical Engineering

Process Calculations and Thermodynamics

Steady and unsteady state mass and energy balances including multiphase, multi-component, reacting and non-reacting systems. Use of tie components; recycle, bypass and purge calculations; Gibb's phase rule and degree of freedom analysis.

First and Second laws of thermodynamics. Applications of first law to close and open systems. Second law and Entropy. Thermodynamic properties of pure substances: Equation of State and residual properties, 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, surface tension, Newtonian and non-Newtonian fluids, transport properties, shell- balances including differential form of Bernoulli equation and energy balance, equation of continuity, equation of motion, equation of mechanical energy, Macroscopic friction factors, dimensional analysis and similitude, flow through pipeline systems, velocity profiles, flow meters, pumps and compressors, elementary boundary layer theory, flow past immersed bodies including packed and fluidized beds, Turbulent flow: fluctuating velocity, universal velocity profile and pressure drop.

Particle size and shape, particle size distribution, size reduction and classification of solid particles; free and hindered settling; centrifuge and cyclones; thickening and classification, filtration, agitation and mixing; conveying of solids.

Heat Transfer

Equation of energy, steady and unsteady heat conduction, convection and radiation, thermal boundary layer and heat transfer coefficients, boiling, condensation and evaporation; types of heat exchangers and evaporators and their process calculations; design of double pipe, shell and tube heat exchangers, and single and multiple effect evaporators.

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, membrane separations (micro-filtration, ultra-filtration, nano- filtration and reverse osmosis).

Chemical Reaction Engineering

Theories of reaction rates; kinetics of homogeneous reactions, interpretation of kinetic data, single and multiple reactions in ideal reactors, kinetics of enzyme reactions (Michaelis-Mentenand Monod models), non-ideal reactors; residence time distribution, single parameter model; non- isothermal reactors; kinetics of

heterogeneous catalytic reactions; diffusion effects in catalysis; rate and performance equations for catalyst deactivation.

Instrumentation and Process Control

Measurement of process variables; sensors and transducers; P&ID equipment symbols; process modeling and linearization, transfer functions and dynamic responses of various systems, systems with inverse response, process reaction curve, controller modes (P, PI, and PID); control valves; transducer dynamics; analysis of closed loop systems including stability, frequency response, controller tuning, cascade and feed forward control.

Plant Design and Economics

Principles of process economics and cost estimation including depreciation and total annualized cost, cost indices, rate of return, payback period, discounted cash flow, optimization in process design and sizing of chemical engineering equipments such as heat exchangers and multistage contactors.

Chemical Technology

Inorganic chemical industries (sulfuric acid, phosphoric acid, chlor-alkali industry), 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).

Computer Science & Engineering/ Information Technology

Digital Logic

Boolean algebra. Combinational and sequential circuits. Minimization. Number representations and computer arithmetic (fixed and floating point).

Computer Organization and Architecture

Machine instructions and addressing modes. ALU, data□path and control unit. Instruction pipelining, pipeline hazards. Memory hierarchy: cache, main memory and secondary storage; I/O interface (interrupt and DMA mode).

Programming and Data Structures

Programming in C. Recursion. Arrays, stacks, queues, linked lists, trees, binary search trees, binary heaps, graphs.

Algorithms

Searching, sorting, hashing. Asymptotic worst case time and space complexity. Algorithm design techniques: greedy, dynamic programming and divide□and□conquer. Graph traversals, minimum spanning trees, shortest paths.

Theory of Computation

Regular expressions and finite automata. Context-free grammars and push-down automata. Regular and context-free languages, pumping lemma. Turing machines and undecidability.

Compiler Design

Lexical analysis, parsing, syntax-directed translation. Runtime environments. Intermediate code generation. Local optimisation, Data flow analyses: constant propagation, liveness analysis, common sub expression elimination.

Operating System

System calls, processes, threads, inter□process communication, concurrency and synchronization. Deadlock. CPU and I/O scheduling. Memory management and virtual memory. File systems.

Databases

ER□model. Relational model: relational algebra, tuple calculus, SQL. Integrity constraints, normal forms. File organization, indexing (e.g., B and B+ trees). Transactions and concurrency control.

Computer Networks

Concept of layering: OSI and TCP/IP Protocol Stacks; Basics of packet, circuit and virtual circuit- switching; Data link layer: framing, error detection, Medium Access Control, Ethernet bridging; Routing protocols: shortest path, flooding, distance vector and link state routing; Fragmentation and IP addressing, IPv4, CIDR

notation, Basics of IP support protocols (ARP, DHCP, ICMP), Network Address Translation (NAT); Transport layer: flow control and congestion control, UDP, TCP, sockets; Application layer protocols: DNS, SMTP, HTTP, FTP, Email.

Basics of Machine Learning

Basic of Machine Learning: Supervised and unsupervised learning, regression and classification

Basic of Neural Networks and back propagation

Concepts of model evaluation: accuracy, precision, recall, confusion matrix

Electronics and Communication Engineering

Networks, Signals and Systems

Circuit Analysis: Node and mesh analysis, superposition, Thevenin's theorem, Norton's theorem, reciprocity. Sinusoidal steady state analysis: phasors, complex power, maximum power transfer. Time and frequency domain analysis of linear circuits: RL, RC and RLC circuits, solution of network equations using Laplace transform.

Linear 2-port network parameters, wye-delta transformation.

Continuous-time Signals: Fourier series and Fourier transform, sampling theorem and applications.

Discrete-time Signals: DTFT, DFT, z-transform, discrete-time processing of continuous-time signals. LTI systems: definition and properties, causality, stability, impulse response, convolution, poles and zeroes, frequency response, group delay, phase delay.

Electronic Devices

Energy bands in intrinsic and extrinsic semiconductors, equilibrium carrier concentration, direct and indirect band-gap semiconductors.

Carrier Transport: Diffusion current, drift current, mobility and resistivity, generation and recombination of carriers, Poisson and continuity equations.

P-N junction, Zener diode, BJT, MOS capacitor, MOSFET, LED, photo diode and solar cell.

Analog Circuits

Diode Circuits: Clipping, clamping and rectifiers.

BJT and MOSFET Amplifiers: Biasing, AC coupling, small signal analysis, frequency response. Current mirrors and differential amplifiers.

Op-amp Circuits: Amplifiers, summers, differentiators, integrators, active filters, Schmitt triggers and oscillators.

Digital Circuits

Number Representations: Binary, integer and floating-point- numbers. Combinatorial circuits: Boolean algebra, minimization of functions using Boolean identities and Karnaugh map, logic gates and their static CMOS implementations, arithmetic circuits, code converters, multiplexers, decoders.

Sequential Circuits: Latches and flip-flops, counters, shift-registers, finite state machines, propagation delay, setup and hold time, critical path delay.

Data Converters: Sample and hold circuits, ADCs and DACs.

Semiconductor Memories: ROM, SRAM, DRAM.

Computer Organization: Machine instructions and addressing modes, ALU, data-path and control
unit, instruction pipelining.

Control Systems

Basic control system components; Feedback principle; Transfer function; Block diagram representation; Signal flow graph; Transient and steady-state analysis of LTI systems; Frequency response; Routh-Hurwitz and Nyquist stability criteria; Bode and root-locus plots; Lag, lead and lag-lead compensation; State variable model and solution of state equation of LTI systems.

Communications

Random Processes: Auto correlation and power spectral density, properties of white noise, filtering of random signals through LTI systems.

Analog Communications: Amplitude modulation and demodulation, angle modulation and demodulation, spectra of AM and FM, super heterodyne receivers.

Information Theory: Entropy, mutual information and channel capacity theorem.

Digital Communications: PCM, DPCM, digital modulation schemes (ASK, PSK, FSK, QAM), bandwidth, inter-symbol interference, MAP, ML detection, matched filter receiver, SNR and BER. Fundamentals of error correction, Hamming codes, CRC.

Electromagnetics

Maxwell's Equations: Differential and integral forms and their interpretation, boundary conditions, wave equation, Poynting vector.

Plane Waves and Properties: Reflection and refraction, polarization, phase and group velocity, propagation through various media, skin depth.

Transmission Lines: Equations, characteristic impedance, impedance matching, impedance transformation, S-parameters, Smith chart. Rectangular and circular waveguides, light propagation in optical fibers, dipole and monopole antennas, linear antenna arrays.

Power Electronics

Static V-I characteristics of and firing/gating circuits for Thyristor/ SCR, MOSFET, IGBT; DC to DC conversion: Buck, Boost and Buck-Boost Converters; Single and three-phase configuration of un-controlled/ Controlled rectifiers; Voltage and Current commutated Thyristor based converters; Bi-directional Ac to Dc voltage source converters; Magnitude and Phase of line current harmonics for un-controlled and thyristor based converters; Power factor and Distortion Factor of AC to DC converters; Single-phase voltage and current source inverters, sinusoidal pulse width modulation and different modulation techniques for converters.

Electrical and Electronics Engineering

Electric circuits

Network Elements: Ideal voltage and current sources, dependent sources, R, L, C, M elements; Network solution methods: KCL, KVL, Node and Mesh analysis; Network Theorems: Thevenin's, Norton's, Superposition and Maximum Power Transfer theorem; Transient response of DC and AC networks, sinusoidal steady-state analysis, resonance, two port networks, balanced three phase circuits, star-delta transformation, complex power and power factor in AC circuits.

Electromagnetic Fields

Coulomb's Law, Electric Field Intensity, Electric Flux Density, Gauss's Law, Divergence, Electric field and potential due to point, line, plane and spherical charge distributions, Effect of dielectric medium, Capacitance of simple configurations, Biot Savart's law, Ampere's law, Curl, Faraday's law, Lorentz force, Inductance, Magnetomotive force, Reluctance, Magnetic circuits, Self and Mutual inductance of simple configurations.

Signals and Systems

Representation of continuous and discrete time signals, shifting and scaling properties, linear time invariant and causal systems, Fourier series representation of continuous and discrete time periodic signals, sampling theorem, Applications of Fourier Transform for continuous and discrete time signals, Laplace Transform and Z transform. R.M.S. value, average value calculation for any general periodic waveform.

Electrical Machines

Single phase transformer: equivalent circuit, phasor diagram, open circuit and short circuit tests, regulation and efficiency; Three-phase transformers: connections, vector groups, parallel operation; Auto-transformer, Electromechanical energy conversion principles; DC machines: separately excited, series and shunt, motoring and generating mode of operation and their characteristics, speed control of dc motors; Three-phase induction machines: principle of operation, types, performance, torque-speed characteristics, no-load and blocked-rotor tests, equivalent circuit, starting and speed control; Operating principle of single-phase induction motors; Synchronous machines: cylindrical and salient pole machines, performance and characteristics, regulation and parallel operation of generators, starting of synchronous motors; Types of losses and efficiency calculations of electric machines.

Power Systems

Basic concepts of electrical power generation, AC and DC transmission concepts, Models and performance of transmission lines and cables, Economic Load Dispatch (with and without considering transmission losses), Series and shunt compensation, Electric field distribution and insulators, Distribution systems, Per unit quantities, Bus admittance matrix, Gauss- Seidel and Newton-Raphson load flow methods, Voltage and Frequency control, Power factor correction, Symmetrical components, Symmetrical and unsymmetrical fault analysis, Principles of over current,

differential, directional and distance protection; Circuit breakers, System stability concepts, Equal area criterion.

Control Systems

Mathematical modelling and representation of systems, Feedback principle, transfer function, Block diagrams and Signal flow graphs, Transient and Steady□state analysis of linear time invariant systems, Stability analysis using Routh-Hurwitz and Nyquist criteria, Bode plots, Root loci, Lag, Lead and Lead□Lag compensators; P, PI and PID controllers; State space model, Solution of state equations of LTI systems.

Electrical and Electronic Measurements

Bridges and Potentiometers, Measurement of voltage, current, power, energy and power factor; Instrument transformers, Digital voltmeters and multi-meters, Phase, Time and Frequency measurement; Oscilloscopes, Error analysis.

Analog and Digital Electronics

Simple diode circuits: clipping, clamping, rectifiers; Amplifiers: biasing, equivalent circuit and frequency response; oscillators and feedback amplifiers; operational amplifiers: characteristics and applications; single stage active filters, Active Filters: Sallen Key, Butterwoth, VCOs and timers, combinatorial and sequential logic circuits, multiplexers, demultiplexers, Schmitt triggers, sample and hold circuits, A/D and D/A converters.

Power Electronics

Static V-I characteristics and firing/gating circuits for Thyristor, MOSFET, IGBT; DC to DC conversion: Buck, Boost and Buck-Boost Converters; Single and three-phase configuration of uncontrolled rectifiers; Voltage and Current commutated Thyristor based converters; Bidirectional ac to dc voltage source converters; Magnitude and Phase of line current harmonics for uncontrolled and thyristor based converters; Power factor and Distortion Factor of AC to DC converters; Single- phase and three-phase voltage and current source inverters, sinusoidal pulse width modulation.

Food Technology

Food Microbiology

Characteristics of Microorganisms: Morphology of bacteria, yeast, mold and actinomycetes, spores and vegetative cells, gram staining.

Microbial Growth: Growth and death kinetics, serial dilution technique.

Food Spoilage: Spoilage microorganisms in different food products including milk, fish, meat, egg, cereals and their products.

Toxins from Microbes: Pathogens and non-pathogens including Staphylococcus, Salmonella, Shigella, Escherichia, Bacillus, Clostridium, and Aspergillus genera.

Fermented Foods and Beverages: Curd, yoghurt, cheese, pickles, soya-sauce, sauerkraut, idli, dosa, vinegar, alcoholic beverages and sausage.

Food Products Technology

Processing Principles: Thermal processing, chilling, freezing, dehydration, addition of preservatives and food additives, irradiation, fermentation, hurdle technology, intermediate moisture foods. Food pack aging and storage: packaging materials, aseptic packaging, controlled and modified atmosphere storage. Cereal processing and products: milling of rice, wheat, and maize, parboiling of paddy, bread, biscuits, extruded products and ready to eat breakfast cereals.

Oil Processing: Expelling, solvent extraction, refining and hydrogenation.

Fruits and Vegetables Processing: Extraction, clarification, concentration and packaging of fruit juice, jam, jelly, marmalade, squash, candies, tomato sauce, ketchup, and puree, potato chips, pickles.

Plantation crops processing and products: Tea, coffee, cocoa, spice, extraction of essential oils and oleoresins from spices.

Milk and Milk Products Processing: Pasteurization and sterilization, cream, butter, ghee, ice- cream, cheese and milk powder. Processing of animal products: drying, canning, and freezing of fish and meat; production of egg powder.

Waste Utilization: Pectin from fruit wastes, uses of by-products from rice milling.

Food standards and Quality Maintenance: FPO, PFA, A-Mark, ISI, HACCP, food plant sanitation and cleaning in place (CIP).

Food Engineering

Mass and energy balance.

Momentum Transfer: Flow rate and pressure drop relationships for Newtonian fluids flowing through pipe, Reynolds number. Heat transfer: heat transfer by conduction, convection, radiation, heat exchangers.

Mass Transfer: Molecular diffusion and Flick's law, conduction and convective mass transfer, permeability through single and multilayer films.

Mechanical Operations: Size reduction of solids, high pressure homogenization, filtration, centrifugation, settling, sieving, mixing & agitation of liquid. Thermal operations: thermal sterilization, evaporation of liquid foods, hot air drying of solids, spray and freeze-drying, freezing and crystallization.

Mass Transfer Operations: Psychometric, humidification and dehumidification operations.

Industrial Chemistry

Process Calculations and Thermodynamics

Steady and unsteady state mass and energy balances including multiphase, multi-component, reacting and non-reacting systems. Use of tie components; recycle, bypass and purge calculations; Gibb's phase rule and degree of freedom analysis.
First and Second laws of thermodynamics. Applications of first law to close and open systems. Second law and Entropy. Thermodynamic properties of pure substances: Equation of State and residual properties, 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, surface tension, Newtonian and non-Newtonian fluids, transport properties, shell- balances including differential form of Bernoulli equation and energy balance, equation of continuity, equation of motion, equation of mechanical energy, Macroscopic friction factors, dimensional analysis and similitude, flow through pipeline systems, velocity profiles, flow meters, pumps and compressors, elementary boundary layer theory, flow past immersed bodies including packed and fluidized beds, Turbulent flow: fluctuating velocity, universal velocity profile and pressure drop.
Particle size and shape, particle size distribution, size reduction and classification of solid particles; free and hindered settling; centrifuge and cyclones; thickening and classification, filtration, agitation and mixing; conveying of solids.

Heat Transfer

Equation of energy, steady and unsteady heat conduction, convection, thermal boundary layer and heat transfer coefficients, boiling, condensation and evaporation; types of heat exchangers and evaporators and their process calculations; single and multiple effect evaporators.

Mass Transfer

Fick's laws, molecular diffusion in fluids, mass transfer coefficients, film, penetration and surface renewal theories; momentum, heat and mass transfer analogies; interphase mass transfer, stage-wise and continuous contacting and stage efficiencies; distillation.

Chemical Reaction Engineering

Theories of reaction rates; kinetics of homogeneous reactions, interpretation of kinetic data, single and multiple reactions in ideal reactors, Explain the different types of reactors and their applications.

Chemical Technology

Sulfuric acid industry (Manufacture of sulphuric acid by Chamber and Contact process), fertilizers (Ammonia, Urea); natural products industries (Pulp and Paper, Sugar, Oil, and Fats).

Organic Synthesis

Reagents in Organic Synthesis:

Use of following reagents in Organic Synthesis and functional group transformations: Complex metal hydrides, Stereoselectivity in hydride reduction, Catalytic

hydrogenation(Homogenous and Heterogeneous) and dissolving metal reductions, Lithium diisopropyl-amide (LDA), dicyclohexylcarbodiimide, Umpolung of reactivity (dipole inversions), trimethylsilyl iodide, trin-butyltin hydride, Oxidation of alcohols to carbonyl. Phenols to quinones, Osmium tetraoxide, selenium dioxide, phase transfer catalysis, Crown ethers, conversion of alkene to epoxides and diols, Oxidative bond cleavages.

Pericyclic reactions: Concerted reactions, unimolecular rearrangement and elimination, Electrocyclic sigmatropic and cycloaddition reactions, Correlation diagrams and FMO theory, Diels-Alder reactions, general feature, Dienophiles, Diene (2+2) cycloadditions, Cope and Claisen rearrangement, Enereaction.

Surface Chemistry

Photochemistry:

Jablonski diagram, Laws of photochemistry, quantum yield, photosensitization and quenching. Stern Volmer equation, Chemiluminescence, Kinetics of photo stationary state of O3

Electrochemistry

Ionic Interaction: Non-ideal behavior of electrolyte solutions. Ionsolvent interaction, activity and activity coefficient, ionic strength, derivation of Debye-Huckel equation and its extension. Quantitative aspects of the Debye-Huckel-Onsager equation, Debye-Huckel-Jerrum model, Interfacial Phenomena: Electrical double layer,,Structure of the double layer : Helmholtz-Perrin, Gouy Chapman, and Stern models. electrocapillarity, thermodynamics of electrified interface electrical capacitance at interphase, Overpotentials, exchange current density, derivation of Butler- volmer equation, Tafelplots.

Analytical Techniques

X-ray Crystallography-Fundamentals: X-ray and their properties. Use of X-ray diffraction to find atomic arrangements. Point group, space group and unit cell.
IR Spectroscopy: Principle, Theory: molecular vibrations, vibrational frequency, selection rules, factors affecting vibrational frequency, finger print region, identification of organic compounds on the basis of infrared spectra.
UV-Vis Spectroscopy: Introduction, laws of absorption, origin of spectra, types of transitions, transition probability, factors affecting absorption, identification of organic compounds based on Woodward-Fieser rules.
NMR: Principle, chemical shift, factors affecting chemical shift, solvent effects, splitting and spin- spin coupling, spectra and molecular structure, identification of organic compounds on the basis of NMR.

Mechanical Engineering

Applied Mechanics and Design

Engineering Mechanics: Free-body diagrams and equilibrium; friction and its applications including rolling friction, belt-pulley, brakes, clutches, screw jack, wedge, vehicles, etc.; trusses and frames; virtual work; kinematics and dynamics of rigid bodies in plane motion; impulse and momentum (linear and angular) and energy formulations; Lagrange's equation.

Mechanics of Materials: Stress and strain, elastic constants, Poisson's ratio; Mohr's circle for plane stress and plane strain; thin cylinders; shear force and bending moment diagrams; bending and shear stresses; concept of shear centre; deflection of beams; torsion of circular shafts; Euler's theory of columns; energy methods; thermal stresses; strain gauges and rosettes; testing of materials with universal testing machine; testing of hardness and impact strength.

Theory of Machines: Displacement, velocity and acceleration analysis of plane mechanisms; dynamic analysis of linkages; cams; gears and gear trains; flywheels and governors; balancing of reciprocating and rotating masses; gyroscope.

Vibrations: Free and forced vibration of single degree of freedom systems, effect of damping; vibration isolation; resonance; critical speeds of shafts. Machine 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, gears, rolling and sliding contact bearings, brakes and clutches, springs.

Fluid Mechanics and Thermal Sciences

Fluid Mechanics: Fluid properties; fluid statics, forces on submerged bodies, stability of floating bodies; control-volume analysis of mass, momentum and energy; fluid acceleration; differential equations of continuity and momentum; Bernoulli's equation; dimensional analysis; viscous flow of incompressible fluids, boundary layer, elementary turbulent flow, flow through pipes, head losses in pipes, bends and fittings; basics of compressible fluid flow.

Heat-Transfer: Modes of heat transfer; one dimensional heat conduction, resistance concept and electrical analogy, heat transfer through fins; unsteady heat conduction, lumped parameter system, Heisler's charts; thermal boundary layer, dimensionless parameters in free and forced convective heat transfer, heat transfer correlations for flow over flat plates and through pipes, effect of turbulence; heat exchanger performance, LMTD and NTU methods; radiative heat transfer, Stefan- Boltzmann law, Wien's displacement law, black and grey surfaces, view factors, radiation network analysis

Thermodynamics: Thermodynamic systems and processes; properties of pure substances, behavior of ideal and real gases; zeroth and first laws of thermodynamics, calculation of work and heat in various processes; second law of thermodynamics;

thermodynamic property charts and tables, availability and irreversibility; thermodynamic relations.

Applications: *Power Engineering*: Air and gas compressors; vapour and gas power cycles, concepts of regeneration and reheat. *I.C. Engines*: Air-standard Otto, Diesel and dual cycles. *Refrigeration and air-conditioning*: Vapour and gas refrigeration and heat pump cycles; properties of moist air, psychrometric chart, basic psychrometric processes. *Turbomachinery*: Impulse and reaction principles, velocity diagrams, Pelton-wheel, Francis and Kaplan turbines; steam and gas turbines.

Materials, Manufacturing and Industrial Engineering

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

Casting, Forming and Joining Processes: Different types of castings, design of patterns, moulds and cores; solidification and cooling; riser and gating design. 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. Principles of welding, brazing, soldering and adhesive bonding.

Machining and Machine Tool Operations: Mechanics of machining; basic machine tools; 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, jigs and fixtures; abrasive machining processes; NC/CNC machines and CNC programming.

Metrology and Inspection: Limits, fits and tolerances; linear and angular measurements; comparators; interferometry; form and finish measurement; alignment and testing methods; tolerance analysis in manufacturing and assembly; concepts of coordinate-measuring machine (CMM).

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

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

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

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