


**B.Sc.(CBCS) II yr, III – Semester Question bank for practical exams**

1. Determine the Co-efficient of thermal conductivity of a bad conductor by Lee's method.
2. Determine Stefan's constant.
3. Find Specific heat of oil using Newton's law of cooling correction.
4. Find efficiency of given electrical kettle.
5. Find thermo emf of given material.
6. Find temperature coefficient of a given resistance thermometer
7. Calibrate a given resistance thermometer
8. Determine thermal expansion coefficient of a given material
9. Study conversion efficiency of mechanical energy to electrical energy converter
10. Determine specific heat of a graphite rod
11. Determine A and B constants of given thermister
12. Draw the temperature characteristics of a given thermister

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CHAIRMAN  
Board of Studies in Physics  
Osmania University, Hyd.

Osmania University

1. Construct Half wave & full wave rectifiers and measure their ripple factors
2. Construct bridge rectifier with diodes and observe its output waveform. Find its ripple factor
3. Construct fullwave rectifier with series inductor filter and find its ripple factor
4. Construct fullwave rectifier with shunt capacitor and find its ripple factor
5. Construct bridge rectifier with L-Section filter and find its ripple factor
6. Construct bridge rectifier with  $\pi$  – section filter and find its ripple factor
7. Construct voltage regulator with 7805 and study its load regulation characteristics
8. Construct voltage regulator with 7805 and study its line regulation characteristics
9. Construct voltage regulator with 7905 and study its load regulation characteristics
10. Construct voltage regulator with 7905 and study its line regulation characteristics
11. Construct colpitt's oscillator and find its frequency of oscillation
12. Construct RC phase shift oscillator and find its frequency of oscillation
13. Construct Astable multivibrator and determine its frequency of oscillation
14. Construct Astable multivibrator and find time and duty cycle
15. Simulate half wave, full wave and bridge rectifiers and find their ripple factors
16. Simulate colpitt's oscillator and find its frequency of oscillation
17. Simulate wein's bridge oscillator and find its frequency of oscillation
18. Simulate RC coupled amplifier and study its frequency response
19. Simulate RC Phase shift oscillator and study its frequency of oscillation
20. Simulate astable multivibrator for 100% duty cycle

With Effect from the Academic Year 2017-2018

**Data Structures Lab****BS306****Practical****2 Hours/Week****1 credit**

- 1 Write programs to implement the following using an array: a) Stack ADT b) Queue ADT.
- 2 Write a program to convert the given infix expression to postfix expression using stack.
- 3 Write a program to evaluate a postfix expression using stack.
- 4 Write a program to ensure the parentheses are nested correctly in an arithmetic expression.
- 5 Write a program to find following using Recursion
  - a) Factorial of +ve Integer b)  $n^{\text{th}}$  term of the Fibonacci Sequence c) GCD of two +ve integers
- 6 Write a program to create a single linked list and write functions to implement the following operations.
  - a. Insert an element at a specified position
  - b. Delete a specified element in the list
  - c. Search for an element and find its position in the list
  - d. Sort the elements in the list ascending order
- 7 Write a program to create a double linked list and write functions to implement the following operations.
  - a. Insert an element at a specified position
  - b. Delete a specified element in the list
  - c. Search for an element and find its position in the list
  - d. Sort the elements in the list ascending order
- 8 Write a program to create singular circular linked lists and function to implement the following operations.
  - a. Insert an element at a specified position
  - b. Delete a specified element in the list
  - c. Search for an element and find its position in the list
- 9 Write programs to implement the following using a single linked list:
  - a. Stack ADT b. Queue ADT.
- 10 Write a program to implement Binary search technique using Iterative method and Recursive methods.
- 11 Write a program for sorting the given list numbers in ascending order using the following technique: Bubble sort and Selection sort
- 12 Write a program for sorting the given list numbers in ascending order using the following technique: Insertion sort and Quick sort
- 13 Write a program for sorting the given list numbers in ascending order using the following technique: Merge sort and Heap sort
- 14 Write a program to traverse a binary tree in following way.
  - a. Pre-order b. In-order c. Post-order
- 15 Write a program to the implementation graph traversals – BFS and DFS.
- 16 Write a program to find the minimum spanning tree for a weighted graph using
  - a. Prim's Algorithm b. Kruskal's Algorithm.

**Note** Write the Pseudo Code for the above programs.

Recommended to use Open Source Software: GCC on Linux; DevC++ (or) CodeBlocks on Windows.

**Relational Database Management Systems Lab****306****Practical****2 Hours/Week****1 credit**Consider the relational schema for part of the **DreamHome** case study is:**Branch** (branchNo, street, city, postcode)**Staff** (staffNo, fName, lName, position, sex, DOB, salary, branchNo)**PropertyForRent** (propertyNo, street, city, postcode, type, rooms, rent, ownerNo, staffNo, branchNo)**Client** (clientNo, fName, lName, telNo, prefType, maxRent, eMail)**PrivateOwner** (ownerNo, fName, lName, address, telNo, eMail, password)**Viewing** (clientNo, propertyNo, viewDate, comment)**Registration** (clientNo, branchNo, staffNo, dateJoined)

1. Create a database with name "DreamHome" and now create all the tables listed above with constraints.
2. Insert a new row into the table supplying data for all columns.
3. Modify data in the database using UPDATE
4. Delete data from the database using DELETE
5. Changing a table definition using ALTER
6. Removing a table using DROP
7. Removing rows in table using TRUNCATE
8. Create an index and removing an index
9. Practice other standard SQL commands for creating, modifying, displaying data of tables.
10. List full details of all staff.
11. List all staff with a salary greater than £10000.
12. List the property numbers of all properties that have been viewed.
13. Produce a list of salaries for all staff, showing only the staffNo, fName, lName, and salary details.
14. List all cities where there is either a branch office or a property for rent.
15. List all cities where there is a branch office but no properties for rent.
16. List all cities where there is both a branch office and at least one property for rent.
17. List the names and comments of all clients who have viewed a property for rent.
18. Produce a status report on property viewings.
19. List complete details of all staff who work at the branch in Glasgow.
20. List the addresses of all branch offices in London or Glasgow
21. List all staff with a salary between £20,000 and £30,000.
22. Identify all clients who have viewed all properties with three rooms.
23. How many properties cost more than £350 per month to rent?
24. How many different properties were viewed in May 2013?
25. Find the total number of Managers and the sum of their salaries.
26. Find the minimum, maximum, and average staff salary.
27. Find the number of staff working in each branch and the sum of their salaries.
28. List all managers and supervisors.
29. Find all owners with the string 'Glasgow' in their address.
30. List the details of all viewings on property PG4 where a comment has not been supplied.
31. Produce a list of salaries for all staff, arranged in descending order of salary.
32. Produce an abbreviated list of properties arranged in order of property type.
33. Find the number of staff working in each branch and the sum of their salaries.
34. For each branch office with more than one member of staff, find the number of staff working in each branch and the sum of their salaries.
35. List the staff who work in the branch at '163 Main St'.
36. List all staff whose salary is greater than the average salary, and show by how much their salary is greater than the average.
37. List the properties that are handled by staff who work in the branch at '163 Main St'.
38. Find all staff whose salary is larger than the salary of at least one member of staff at branch B003.
39. Find all staff whose salary is larger than the salary of every member of staff at branch B003
40. List the names of all clients who have viewed a property, along with any comments supplied.
41. For each branch office, list the staff numbers and names of staff who manage properties and the properties that they manage.
42. For each branch, list the staff numbers and names of staff who manage properties, including the city in


- which the branch is located and the properties that the staff manage.
43. Find the number of properties handled by each staff member, along with the branch number of the member of staff.
  44. List all branch offices and any properties that are in the same city.
  45. List all properties and any branch offices that are in the same city.
  46. List the branch offices and properties that are in the same city along with any unmatched branches or properties.
  47. Find all staff who work in a London branch office.
  48. Construct a list of all cities where there is either a branch office or a property.
  49. Construct a list of all cities where there is both a branch office and a property.
  50. Create a view so that the manager at branch B003 can see the details only for staff who work in his or her branch office.
  51. Create a view of the staff details at branch B003 that excludes salary information, so that only managers can access the salary details for staff who work at their branch.
  52. Create a view of staff who manage properties for rent, which includes the branch number they work at, their staff number, and the number of properties they manage.
  53. Removing a view using DROP VIEW
  54. Give the user with authorization identifier Manager all privileges on the Staff table.
  55. Give users Personnel and Director the privileges SELECT and UPDATE on column salary of the Staff table.
  56. Revoke the privilege SELECT on the Branch table from all users.
  57. Revoke all privileges you have given to Director on the Staff table.
  58. Demonstrate exceptions in PL/SQL
  59. Demonstrate cursors in PL/SQL
  60. Write PL/SQL queries to create procedures.
  61. Write PL/SQL queries to create functions.
  62. Write PL/SQL queries to create package.
  63. Write PL/SQL queries to create triggers.
  64. Write PL/SQL queries using recursion.
- Consider the relational schema for part of the Hotel case study is:
- Hotel (hotelNo, hotelName, city)  
Room (roomNo, hotelNo, type, price)  
Booking (hotelNo, guestNo, dateFrom, dateTo, roomNo)  
Guest (guestNo, guestName, guestAddress)
65. Create a database with name "Hotel" and now create all the tables listed above with constraints.
  66. Insert a new row into the table supplying data for all columns.
  67. Modify data in the database using UPDATE
  68. Delete data from the database using DELETE
  69. Changing a table definition using ALTER
  70. Removing a table using DROP
  71. Removing rows in table using TRUNCATE
  72. Practice other standard SQL commands for creating, modifying, displaying data of tables.
  73. List full details of all hotels.
  74. List full details of all hotels in London.
  75. List the names and addresses of all guests living in London, alphabetically ordered by name.
  76. List all double or family rooms with a price below £40.00 per night, in ascending order of price.
  77. List the bookings for which no dateTo has been specified.
  78. How many hotels are there?
  79. What is the average price of a room?
  80. What is the total revenue per night from all double rooms?
  81. How many different guests have made bookings for August?
  82. List the price and type of all rooms at the Grosvenor Hotel.
  83. List all guests currently staying at the Grosvenor Hotel.
  84. List the details of all rooms at the Grosvenor Hotel, including the name of the guest staying in the room, if the room is occupied.
  85. What is the total income from bookings for the Grosvenor Hotel today?
  86. List the rooms that are currently unoccupied at the Grosvenor Hotel.
  87. What is the lost income from unoccupied rooms at the Grosvenor Hotel?
  88. List the number of rooms in each hotel.
  89. List the number of rooms in each hotel in London.
  90. What is the average number of bookings for each hotel in August?

91. What is the most commonly booked room type for each hotel in London?
92. What is the lost income from unoccupied rooms at each hotel today?
93. Insert rows into each of these tables.
94. Update the price of all rooms by 5%.
95. Investigate the SQL dialect on any DBMS that you are currently using. Determine the system's compliance with the DML statements of the ISO standard. Investigate the functionality of any extensions that the DBMS supports. Are there any functions not supported?
96. Demonstrate that queries written using the UNION operator can be rewritten using the OR operator to produce the same result.
97. Apply the syntax for inserting data into a table.
98. Create a view containing the cheapest hotels in the world.
99. Create the Hotel table using the integrity enhancement features of SQL.
100. Create a database trigger for the following situations:
  - (a) The price of all double rooms must be greater than £100.
  - (b) The price of double rooms must be greater than the price of the highest single room.
  - (c) A booking cannot be for a hotel room that is already booked for any of the specified dates.
  - (d) A guest cannot make two bookings with overlapping dates.
  - (e) Maintain an audit table with the names and addresses of all guests who make bookings for hotels in London (do not store duplicate guest details).

**Note** : Recommended to use open source database software like MySQL, MongoDB, PostgreSQL, etc...

In practical examination, students have to

- Create database
- Create tables with their integrity constraints.
- Insert the data into tables and then execute the queries.
- Answer any **six** queries from **ten** queries given by the examiner.

  
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**B.Sc. BOTANY (CBCS)**

**III-Semester**

**Paper – III**

**Taxonomy of Angiosperms and Medicinal Botany**

**I. Technical description of the given plant twig 'A'**

1. Annonaceae,
2. Capparaceae,
3. Rutaceae,
4. Fabaceae
5. Caesalpinaceae
6. Mimosaceae,
7. Cucurbitaceae,
8. Apiceae,
9. Asteraceae,
10. Asclepiadaceae,
11. Lamiaceae,
12. Amaranthaceae,
13. Euphorbiaceae,
14. Orchidaceae
15. Poaceae

**II. Identify the given material 'B' & write its medicinal properties**

16. Tulasi (*Oscimum sanctum*)
17. Karakya (*Terminalia chebula*),
18. Kalabanda (*Aloe vera*),

**III. Identify the specimen 'C' & write organoleptic evaluation**

19. pippallu (*Piper longum*),
20. Nela usiri (*Phyllanthus amarus*),
21. Tippateega (*Tinospora cordifolia*),
22. Turmeric (*Curcuma longa*).

**IV. Identify the given material 'D' & Discuss the ethno medicinal value of it**

23. Aswagandha (*Withania somnifera*),
24. Sarpagandha (*Rauvolfia serpentina*),
25. Amla (*Phyllanthus emblica*)
26. Brahmi (*Bacopa monnieri*)

**V. Identify the given material 'E' write the active principle and uses**

27. Tulasi (*Oscimum sanctum*)
28. Karakya (*Terminalia chebula*),
29. Kalabanda (*Aloe vera*),

*Handwritten signature and date:*  
25/10/17



Faculty of Science  
B.Sc. III Semester (Practical) Examination  
Subject: Chemistry; Paper-III  
**QUESTION BANK**  
W.E.F. from 2017

Time: 2 hrs

Max.marks: 25

- I. Write a brief procedure and principle for the following experiment. (5)
  1. Estimation of Carbonate in Washing Soda.
  2. Estimation of Bicarbonate in Baking Soda.
  3. Estimation of Carbonate and bicarbonate in the mixture..
  4. Estimation of Alkali content in Antacid using HCl
  5. The determination of Fe(II) using  $K_2Cr_2O_7$ .
  6. The determination of  $Fe(II)^+$  using  $KMnO_4$  with sodium oxalate as primary standard.
  7. The determination of Cu(II) using  $Na_2S_2O_3$  with  $K_2Cr_2O_7$  as primary standard.
  
- II. Carry out any one experiment allotted from the following. (15)
  1. Estimate the amount of Carbonate present in the given Washing Soda sample. You are provided with
    - (a) A pur sample of  $Na_2CO_3$
    - (b) An approximate 0.1 M HCl solution
  
  2. Estimate the amount of Bicarbonate present in the given Baking Soda sample. You are provided with
    - (a) A pure sample of  $Na_2CO_3$
    - (b) An approximate 0.1 M HCl solution
  
  3. Estimate the amount of Carbonate and Bicarbonate present in the given solution. You are provided with an approximate 0.1 M HCl solution. (no weighing)
  
  4. Estimate the amount of alkali content present in the given antacid. You are provided with
    - (a) 0.2 M NaOH



- (b) 0.2 M HCl solution
5. Estimate the amount of Ferrous ions present in the given solution (dichrometrically).  
You are provided with a pure sample of  $K_2Cr_2O_7$
6. Estimate the amount of Ferrous ions present in the given solution.  
You are provided with
- (a) A pure sample of oxalic acid
  - (b) An approximate 0.02 M  $KMnO_4$  solution
7. Estimate the amount of Copper (II) ions present in the given solution.  
You are provided with
- (a) A pure sample of  $K_2Cr_2O_7$
  - (b) An approximate 0.1 M hypo solution

III. Record and Viva-Voce (5)

B.Sc. III Semester (Practical) Examination  
Subject: Chemistry; Paper-III  
Scheme of Valuation

II.	Procedure and Principle -----	5 marks
III.	(1) Preparation of standard solution-----	3 marks
	(a) Weighing and wrting weights	(2)
	(b) Calculation of molarity	(1)
	(2) Standardisation-----	5 marks
	(a) Tabulation of readings	(1)
	(b) Titration	(3)
	Error upto 3%     - 3	
	Error upto 5%     - 2	
	Error above 5%    - 1	
	(c) Calculation of molarity	(1)
	(3) Estimation	6 marks
	(a) Tabulation of readings	(1)
	(b) Titration	(3)
	Error upto 3%     - 3	
	Error upto 5%     - 2	
	Error above 5%    - 1	
	(c ) Calculation of molarity	(1)
	(d) Calculation of amount	(1)
	(4) Result	1 mark

(For question no 5, as there is no standardization, those marks can be distributed equally to weighing and estimation)

IV.	Record and Viva-Voce	5 marks
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B.Sc. II Year  
Zoology Practical Syllabus for III Semester  
Core Paper – III  
Animal Diversity Vertebrates and Developmental Biology

QUESTION BANK  
WITH EFFECT FROM 2017

Time: 2Hrs.

Max. Marks: 25

I. Identify, Classify and give reasons for identification

[4x2 = 8 marks]

(Marks for identification ½ mark + Classification ½ mark + Diagram ½ mark + Description ½ mark. If classification not applicable, identification ½ mark, Diagram and Description 1½ mark)

Museum specimens and slides

- |  |                            |
|--|----------------------------|
| 1. <i>Amphioxus</i>                      | 35. <i>Naja</i>            |
| 2. <i>Amphioxus</i> T.S. through pharynx | 36. <i>Bungarus</i>        |
| 3. <i>Petromyzon</i>                     | 37. <i>Enhydryna</i>       |
| 4. <i>Myxine</i>                         | 38. <i>Typhlops</i>        |
| 5. <i>Ammocoetus</i> larva               | 39. <i>Testudo</i>         |
| 6. <i>Sphyrna</i>                        | 40. <i>Trionyx</i>         |
| 7. <i>Pristis</i>                        | 41. <i>Crocodylus</i>      |
| 8. <i>Torpedo</i>                        | 42. <i>Ptyas</i>           |
| 9. <i>Channa</i>                         | 43. <i>Archaeopteryx</i>   |
| 10. <i>Pleuronectes</i>                  | 44. <i>Passer</i>          |
| 11. <i>Hippocampus</i>                   | 45. <i>Psittacula</i>      |
| 12. <i>Exocoetus</i>                     | 46. <i>Bubo</i>            |
| 13. <i>Echieneis</i>                     | 47. <i>Alcedo</i>          |
| 14. <i>Labeo</i>                         | 48. <i>Columba</i>         |
| 15. <i>Catla</i>                         | 49. <i>Corvus</i>          |
| 16. <i>Clarius</i>                       | 50. <i>Pavo</i>            |
| 17. <i>Auguilla</i>                      | 51. <i>Ornithorhynchus</i> |
| 18. <i>Protopterus</i>                   | 52. <i>Tachyglossus</i>    |
| 19. Placoid Scales                       | 53. <i>Pteropus</i>        |
| 20. Cycloid Scales                       | 54. <i>Funambulus</i>      |
| 21. Ctenoid Scales                       | 55. <i>Manis</i>           |
| 22. <i>Ichthyophis</i>                   | 56. <i>Loris</i>           |
| 23. <i>Amblystoma</i>                    | 57. Hedgehog               |
| 24. <i>Siren</i>                         | 58. T.S. of Liver          |
| 25. <i>Hyla</i>                          | 59. T.S. of Pancreas       |
| 26. <i>Rachophorus</i>                   | 60. T.S. of Kidney         |
| 27. <i>Bufo</i>                          | 61. T.S. of Stomach        |
| 28. <i>Rana</i>                          | 62. T.S. of Intestine      |
| 29. Axolotal larva                       | 63. T.S. of Lungs          |
| 30. <i>Draco</i>                         | 64. T.S. of Artery         |
| 31. <i>Chamaeleon</i>                    | 65. T.S. of Vein           |
| 32. <i>Gecko</i>                         | 66. T.S. of Bone           |
| 33. <i>Uromastix</i>                     | 67. T.S. of Spinal cord    |
| 34. <i>Vipera russelli</i>               |                            |

**QII. Osteology – [Bones] – 2 spots****[2x1½ = 3 marks]**

- |   |                                |
|---|--------------------------------|
| 68. Dorsal view of Rabbit skull           | 83. Pectoral girdle of Varanus |
| 69. Ventral view of Rabbit skull          | 84. Pelvic girdle of Varanus   |
| 70. Atlas vertebra of Rabbit              | 85. Humerus of fowl            |
| 71. Axis vertebra of Rabbit               | 86. Radio-ulna of fowl         |
| 72. Typical cervical vertebra of Rabbit   | 87. Femur of fowl              |
| 73. Anterior thoracic vertebra of Rabbit  | 88. Tibiofibula of fowl        |
| 74. Posterior thoracic vertebra of Rabbit | 89. Pectoral girdle of fowl    |
| 75. Anterior Lumbar vertebra of Rabbit    | 90. Pelvic girdle of fowl      |
| 76. Posterior Lumbar vertebra of Rabbit   | 91. Furcula of fowl            |
| 77. Sacrum vertebrae of Rabbit            | 92. Humerus of Rabbit          |
| 78. Caudal vertebrae of Rabbit            | 93. Radio-ulna of Rabbit       |
| 79. Humerus of Varanus                    | 94. Femur of Rabbit            |
| 80. Radio-ulna of Varanus                 | 95. Tibiofibula of Rabbit      |
| 81. Femur of Varanus                      | 96. Pectoral girdle of Rabbit  |
| 82. Tibiofibula of Varanus                | 97. Pelvic girdle of Rabbit    |

**Q III. Dissection****[4 marks]**

(Diagram + Dissection and Display)

Dissect and display the \_\_\_\_\_ system \_\_\_\_\_ and draw a neat labelled diagram

- 98. Digestive system of Labeo/Tilapia
- 99. Brain of Labeo/Tilapia
- 100. Weberian ossicles of Labeo
- 101. V and VII cranial nerves in Labeo/Tilapia
- 102. IX and X cranial nerves in Labeo/Tilapia

**QIV. Embryology (Slides/Models)****[2x1½ = 3 marks]**

- 103. T.S of Testis of Rabbit
- 104. T.S. of ovary of Rabbit
- 105. 2 – Cell Stage of Frog
- 106. 4– Cell Stage of Frog
- 107. 8– Cell Stage of Frog
- 108. 16– Cell Stage of Frog
- 109. Morula of Frog
- 110. Blastula of Frog
- 111. 18 hours Chick Embryo
- 112. 24 hours Chick Embryo
- 113. 33 hours Chick Embryo
- 114. 48 hours Chick Embryo

**QV. Certified Practical Record****[3 marks]****QVI. Animal Album****[2 marks]**

[containing photographs, cut outs with write up]

**QVII. Viva-Voce****[2 marks]**

**B.Sc. II Year Zoology**  
**III-Semester(CBCS)**  
**Paper – III: Animal Diversity Vertebrates and Developmental Biology**

**Time: 2Hrs.**

**Max. Marks: 25**

- I. Identify, the given spotters 1-4 (3 specimens & 1 Slide), given reasons for identification with a neat labeled diagram  
(4x2 = 8 Marks)
- II. Identify the spots 2 osteology and write your comments  
(3 Marks)
- III. Dissect, display and draw a neat labeled diagram  
(4 Marks)
- IV. Identify draw neat labeled diagram of the 2 embryology slides  
(3 Marks)
- V. Certified practical record  
(3 Marks)
- VI. Animal album  
(2 Marks)
- VII. Viva voce  
(2 Marks)

## 2.5.1 Practicals Question Bank

### Real Analysis

#### Unit-I

1. For each sequence below, determine whether it converges and, if it converges, give its limit. No proofs are required.

(a)  $a_n = \frac{n}{n+1}$

(b)  $b_n = \frac{n^2+3}{n^2-3}$

(c)  $c_n = 2^{-n}$

(d)  $t_n = 1 + \frac{2}{n}$

(e)  $x_n = 73 + (-1)^n$

(f)  $s_n = (2)^{\frac{1}{n}}$

2. Determine the limits of the following sequences, and then prove your claims.

(a)  $a_n = \frac{n}{n^2+1}$

(b)  $b_n = \frac{7n-19}{3n+7}$

(c)  $c_n = \frac{4n+3}{7n-5}$

(d)  $d_n = \frac{2n+4}{5n+2}$

(e)  $s_n = \frac{1}{n} \sin n$

3. Suppose  $\lim a_n = a$ ,  $\lim b_n = b$ , and  $s_n = \frac{a_n^3 + 4a_n}{b_n^2 + 1}$ . Prove  $\lim s_n = \frac{a^3 + 4a}{b^2 + 1}$  carefully, using the limit theorems.

4. Let  $x_1 = 1$  and  $x_{n+1} = 3x_n^2$  for  $n \geq 1$ .

(a) Show if  $a = \lim x_n$ , then  $a = \frac{1}{3}$  or  $a = 0$ .

(b) Does  $\lim x_n$  exist? Explain.

(c) Discuss the apparent contradiction between parts (a) and (b).

5. Which of the following sequences are increasing? decreasing? bounded?

(a)  $\frac{1}{n}$

(b)  $\frac{(-1)^n}{n^2}$

(c)  $n^5$

(d)  $\sin(\frac{n\pi}{7})$

(e)  $(-2)^n$

(f)  $\frac{n}{3^n}$

6. Let  $(s_n)$  be a sequence such that  $|s_{n+1} - s_n| < 2^{-n}$  for all  $n \in \mathbb{N}$ . Prove  $(s_n)$  is a Cauchy sequence and hence a convergent sequence.

7. Let  $(s_n)$  be an increasing sequence of positive numbers and define  $\sigma_n = \frac{1}{n}(s_1 + s_2 + \dots + s_n)$ . Prove  $(\sigma_n)$  is an increasing sequence.

8. Let  $t_1 = 1$  and  $t_{n+1} = [1 - \frac{1}{4n^2}] \cdot t_n$  for  $n \geq 1$ .

(a) Show  $\lim t_n$  exists.

(b) What do you think  $\lim t_n$  is?

9. Let  $t_1 = 1$  and  $t_{n+1} = [1 - \frac{1}{(n+1)^2}] \cdot t_n$  for all  $n \geq 1$ .
- Show  $\lim t_n$  exists.
  - What do you think  $\lim t_n$  is?
  - Use induction to show  $t_n = \frac{n+1}{2^n}$ .
  - Repeat part (b).
10. Let  $s_1 = 1$  and  $s_{n+1} = \frac{1}{3}(s_n + 1)$  for  $n \geq 1$ .
- Find  $s_2, s_3$  and  $s_4$ .
  - Use induction to show  $s_n > \frac{1}{2}$  for all  $n$ .
  - Show  $(s_n)$  is a decreasing sequence.
  - Show  $\lim s_n$  exists and find  $\lim s_n$ .

### Unit-II

11. Let  $a_n = 3 + 2(-1)^n$  for  $n \in \mathbb{N}$ .
- List the first eight terms of the sequence  $(a_n)$ .
  - Give a subsequence that is constant [takes a single value]. Specify the selection function  $\sigma$ .
12. Consider the sequences defined as follows:
- $$a_n = (-1)^n, b_n = \frac{1}{n}, c_n = n^2, d_n = \frac{6n+4}{7n-3}.$$
- For each sequence, give an example of a monotone subsequence.
  - For each sequence, give its set of subsequential limits.
  - For each sequence, give its  $\limsup$  and  $\liminf$ .
  - Which of the sequences converges? diverges to  $+\infty$ ? diverges to  $-\infty$ ?
  - Which of the sequences is bounded?
13. Prove  $\limsup |s_n| = 0$  if and only if  $\lim s_n = 0$ .
14. Let  $(s_n)$  and  $(t_n)$  be the following sequences that repeat in cycles of four:

$$(s_n) = (0, 1, 2, 1, 0, 1, 2, 1, 0, 1, 2, 1, 0, 1, 2, 1, 0, \dots)$$

$$(t_n) = (2, 1, 1, 0, 2, 1, 1, 0, 2, 1, 1, 0, 2, 1, 1, 0, 2, \dots)$$

Find

- |                                  |                           |
|----------------------------------|---------------------------|
| (a) $\liminf s_n + \liminf t_n,$ | (b) $\liminf(s_n + t_n),$ |
| (c) $\liminf s_n + \limsup t_n,$ | (d) $\limsup(s_n + t_n),$ |



- (e)  $\limsup s_n + \limsup t_n$ , (f)  $\liminf(s_n t_n)$ .
- (g)  $\limsup(s_n t_n)$ .
15. Determine which of the following series converge. Justify your answers.
- (a)  $\sum \frac{n^4}{2^n}$  (b)  $\sum \frac{2^n}{n!}$
- (c)  $\sum \frac{n^2}{3^n}$  (d)  $\sum \frac{n!}{n^4+3}$
- (e)  $\sum \frac{\cos^2 n}{n^2}$  (f)  $\sum_{n=2}^{\infty} \frac{1}{\log n}$
16. Prove that if  $\sum a_n$  is a convergent series of nonnegative numbers and  $p > 1$ , then  $\sum a_n^p$  converges.
17. Show that if  $\sum a_n$  and  $\sum b_n$  are convergent series of nonnegative numbers, then  $\sum \sqrt{a_n b_n}$  converges.  
 Hint: Show  $\sqrt{a_n b_n} \leq a_n + b_n$  for all  $n$ .
18. We have seen that it is often a lot harder to find the value of an infinite sum than to show it exists. Here are some sums that can be handled.
- (a) Calculate  $\sum_{n=1}^{\infty} (\frac{2}{3})^n$  and  $\sum_{n=1}^{\infty} (-\frac{2}{3})^n$ .
- (b) Prove  $\sum_{n=1}^{\infty} \frac{1}{n(n+1)} = 1$ . Hint: Note that  $\sum_{k=1}^n \frac{1}{k(k+1)} = \sum_{k=1}^n [\frac{1}{k} - \frac{1}{k+1}]$ .
- (c) Prove  $\sum_{n=1}^{\infty} \frac{n-1}{2^{n+1}} = \frac{1}{2}$ . Hint: Note  $\frac{k-1}{2^{k+1}} = \frac{k}{2^k} - \frac{k+1}{2^{k+1}}$ .
- (d) Use (c) to calculate  $\sum_{n=1}^{\infty} \frac{n}{2^n}$ .
19. Determine which of the following series converge. Justify your answers.
- (a)  $\sum_{n=2}^{\infty} \frac{1}{\sqrt{n} \log n}$  (b)  $\sum_{n=2}^{\infty} \frac{\log n}{n}$
- (c)  $\sum_{n=4}^{\infty} \frac{1}{n(\log n)(\log \log n)}$  (d)  $\sum_{n=2}^{\infty} \frac{\log n}{n^2}$
20. Show  $\sum_{n=2}^{\infty} \frac{1}{n(\log n)^p}$  converges if and only if  $p > 1$ .

### UNIT-III

21. For each of the following power series, find the radius of convergence and determine the exact interval of convergence.
- (a)  $\sum n^2 x^n$  (b)  $\sum (\frac{x}{n})^n$
- (c)  $\sum (\frac{2^n}{n^2}) x^n$  (d)  $\sum (\frac{n^3}{3^n}) x^n$
- (e)  $\sum (\frac{2^n}{n!}) x^n$  (f)  $\sum (\frac{1}{(n+1)^{2 \cdot 2^n}}) x^n$

- (g)  $\sum (\frac{3^n}{n \cdot 4^n}) x^n$  (h)  $\sum (\frac{(-1)^n}{n^2 \cdot 4^n}) x^n$
22. For  $n = 0, 1, 2, 3, \dots$  let  $a_n = [\frac{4+2(-1)^n}{5}]^n$ .
- (a) Find  $\limsup(a_n)^{1/n}$ ,  $\liminf(a_n)^{1/n}$ ,  $\limsup |\frac{a_{n+1}}{a_n}|$  and  $\liminf |\frac{a_{n+1}}{a_n}|$ .
- (b) Do the series  $\sum a_n$  and  $\sum (-1)^n a_n$  converge? Explain briefly.
23. Let  $f_n(x) = \frac{1+2\cos^2 nx}{\sqrt{n}}$ . Prove carefully that  $(f_n)$  converges uniformly to 0 on  $\mathbb{R}$ .
24. Prove that if  $f_n \rightarrow f$  uniformly on a set  $S$ , and if  $g_n \rightarrow g$  uniformly on  $S$ , then  $f_n + g_n \rightarrow f + g$  uniformly on  $S$ .
25. Let  $f_n(x) = \frac{x^n}{n}$ . Show  $(f_n)$  is uniformly convergent on  $[-1, 1]$  and specify the limit function.
26. Let  $f_n(x) = \frac{n+\cos x}{2n+\sin^2 x}$  for all real numbers  $x$ .
- (a) Show  $(f_n)$  converges uniformly on  $\mathbb{R}$ . Hint: First decide what the limit function is; then show  $(f_n)$  converges uniformly to it.
- (b) Calculate  $\lim_{n \rightarrow \infty} \int_2^7 f_n(x) dx$ . Hint: Don't integrate  $f_n$ .
27. Show  $\sum_{n=1}^{\infty} \frac{1}{n^2} \cos nx$  converges uniformly on  $\mathbb{R}$  to a continuous function.
28. Show  $\sum_{n=1}^{\infty} \frac{x^n}{n^2 2^n}$  has radius of convergence 2 and the series converges uniformly to a continuous function on  $[-2, 2]$ .
29. (a) Show  $\sum \frac{x^n}{1+x^n}$  converges for  $x \in [0, 1]$
- (b) Show that the series converges uniformly on  $[0, a]$  for each  $a$ ,  $0 < a < 1$ .
30. Suppose  $\sum_{k=1}^{\infty} g_k$  and  $\sum_{k=1}^{\infty} h_k$  converge uniformly on a set  $S$ . Show  $\sum_{k=1}^{\infty} (g_k + h_k)$  converges uniformly on  $S$ .

#### UNIT-IV

31. Let  $f(x) = x$  for rational  $x$  and  $f(x) = 0$  for irrational  $x$ .
- (a) Calculate the upper and lower Darboux integrals for  $f$  on the interval  $[0, b]$ .
- (b) Is  $f$  integrable on  $[0, b]$ ?
32. Let  $f$  be a bounded function on  $[a, b]$ . Suppose there exist sequences  $(U_n)$  and  $(L_n)$  of upper and lower Darboux sums for  $f$  such that  $\lim(U_n - L_n) = 0$ . Show  $f$  is integrable and  $\int_a^b f = \lim U_n = \lim L_n$ .
33. A function  $f$  on  $[a, b]$  is called a step function if there exists a partition  $P = \{a = u_0 < u_1 < \dots < u_m = b\}$  of  $[a, b]$  such that  $f$  is constant on each interval  $(u_{j-1}, u_j)$ , say  $f(x) = c_j$  for  $x$  in  $(u_{j-1}, u_j)$ .
- (a) Show that a step function  $f$  is integrable and evaluate  $\int_a^b f$ .
- (b) Evaluate the integral  $\int_0^1 P(x) dx$  for the postage-stamp function.
34. Show  $|\int_{-2\pi}^{2\pi} x^2 \sin^8(e^x) dx| \leq \frac{16\pi^3}{3}$ .

35. Let  $f$  be a bounded function on  $[a, b]$ , so that there exists  $B > 0$  such that  $|f(x)| \leq B$  for all  $x \in [a, b]$ .

(a) Show

$$U(f^2, P) - L(f^2, P) \leq 2B[U(f, P) - L(f, P)]$$

for all partitions  $P$  of  $[a, b]$ . Hint:  $f(x)^2 - f(y)^2 = [f(x) + f(y)][f(x) - f(y)]$

(b) Show that if  $f$  is integrable on  $[a, b]$ , then  $f^2$  also is integrable on  $[a, b]$ .

36. Calculate

(a)  $\lim_{x \rightarrow 0} \frac{1}{x} \int_0^x e^{t^2} dt$

(b)  $\lim_{h \rightarrow 0} \frac{1}{h} \int_3^{3+h} e^{t^2} dt.$

37. Show that if  $f$  is a continuous real-valued function on  $[a, b]$  satisfying  $\int_a^b f(x)g(x)dx = 0$  for every continuous function  $g$  on  $[a, b]$ , then  $f(x) = 0$  for all  $x$  in  $[a, b]$ .
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