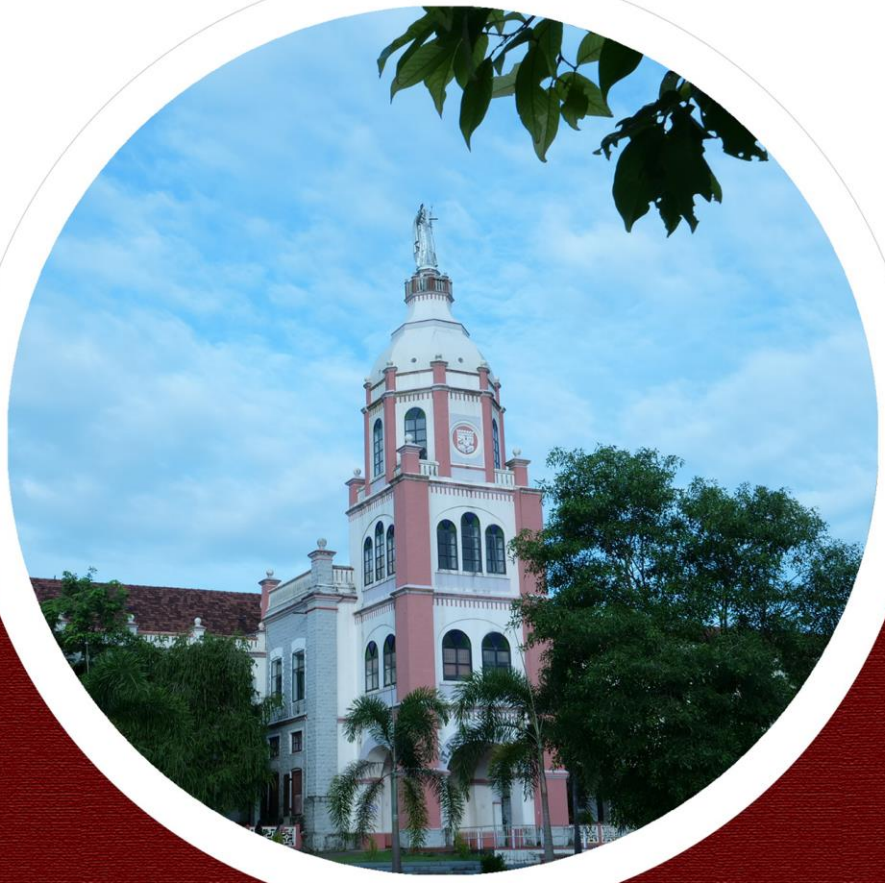
DEPARTMENT OF
CHEMISTRY



Curriculum and Syllabus for BVoc Programme in Industrial Chemistry
Under Credit Semester System
(with effect from 2019 admissions)

St Berchmans College
Founded 1922
AUTONOMOUS | College with Potential for Excellence | Reaccredited by NAAC with A Grade
Affiliated to Mahatma Gandhi University, Kottayam, Kerala
Changanassery, Kottayam, Kerala, India-686101

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Board of Studies

1.	Dr. P C Thomas (HoD & Chairman)	Associate Professor Department of Chemistry St Berchmans College, Changanassery
2.	Dr. Kuruvilla Joseph	Senior Professor & Dean Indian Institute of Space Science & Technology Thiruvananthapuram
3.	Dr. K. Girish Kumar	Professor & Head Department of Applied Chemistry Cochin University of Science and Technology
4.	Dr. Suneesh C. V.	Assistant Professor Department of Chemistry University of Kerala Thiruvananthapuram
5.	Dr. Anas S	Assistant Professor School of Chemical Sciences MG University Kottayam
6.	Mr. Siby Sebastian	Managing Director Sharkline Industries Industrial Estate Nagar Changanassery
7.	Dr. K C Philip	Associate Professor Department of Chemistry St Berchmans College, Changanassery
8.	Dr. Tomlal Jose E	Assistant Professor Department of Chemistry St Berchmans College, Changanassery
9.	Dr. Renjith Thomas	Assistant Professor Department of Chemistry St Berchmans College, Changanassery
10.	Mr. Aravind K	Assistant Professor Department of Chemistry St Berchmans College, Changanassery
11.	Dr. Bejoy Francis	Assistant Professor Department of Chemistry St Berchmans College, Changanassery
12.	Dr. Shijo K Cherian	Assistant Professor Department of Chemistry St Berchmans College, Changanassery
13.	Dr. Cyril Augustine V	Assistant Professor Department of Chemistry St Berchmans College, Changanassery
14.	Dr. Jinesh M Kuthanapillil	Assistant Professor Department of Chemistry St Berchmans College, Changanassery
15.	Mr. Subin Joseph	Assistant Professor Department of Chemistry St Berchmans College, Changanassery

16.	Lt. James Baben George	Assistant Professor Department of Chemistry St Berchmans College, Changanassery
17.	Dr. Benny Thomas	Assistant Professor Department of Chemistry St Berchmans College, Changanassery
18.	Dr. Sam John	Assistant Professor Department of Chemistry St Berchmans College, Changanassery
19.	Dr. Ajith James Jose	Assistant Professor Department of Chemistry St Berchmans College, Changanassery
20.	Dr. Renchu Scaria	Assistant Professor Department of Chemistry St Berchmans College, Changanassery
21.	Mrs. Sajini T	Assistant Professor Department of Chemistry St Berchmans College, Changanassery

REGULATIONS FOR BVOC PROGRAMME IN INDUSTRIAL CHEMISTRY UNDER CREDIT SEMESTER SYSTEM (SB-CSS-BVoc) 2019

1. SHORT TITLE

1.1 These Regulations shall be called St. Berchmans college (Autonomous) Regulations (2019) governing BVoc Programmes under the Credit Semester System (SB-CSS-BVoc).

1.2 These Regulations shall come into force from the Academic Year 2019-2020 onwards.

2. SCOPE

2.1 The regulation provided herein shall apply to BVoc programme in Industrial Chemistry conducted by St. Berchmans College (Autonomous) with effect from the academic year 2019 - 2020.

3. DEFINITIONS

3.1 'University' means Mahatma Gandhi University, Kottayam, Kerala.

3.2 'College' means St. Berchmans College (Autonomous).

3.3 There shall be an Academic Committee nominated by the Principal to look after the matters relating to the SB-CSS-BVoc system.

3.4 'Academic Council' means the Committee consisting of members as provided under section 107 of the Autonomy Ordinance, Government of Kerala.

3.5 'Parent Department' means the Department of Chemistry.

3.6 'Programme' means a three year programme of study and examinations.

3.7 'Duration of Programme' means the period of time required for the conduct of the programme. The duration of the BVoc programme shall be three years consisting of six semesters

3.8 'Course' means a segment of subject matter to be covered in a semester. Each Course is to be designed under lectures/ laboratory work/seminar/project/practical/assignments/ evaluation etc., to meet effective teaching and learning needs.

3.9 'Course Teacher' means the teacher who is taking classes on the course.

3.10 'Project' means a regular project work with stated credits on which the student conducts a project under the supervision of a teacher in the parent department/any appropriate research centre/industry in order to submit a dissertation on the project work as specified.

3.11 'Dissertation' means a minor thesis to be submitted at the end of a research work carried out by each student under the supervision of a teacher in the parent department/other institution on a specific area.

3.12 'Plagiarism' is the unreferenced use of other authors' material in dissertations and is a serious academic offence.

3.13 'Seminar' means a lecture expected to train the student in self-study, collection of relevant matter from books and internet resources, editing, document writing, typing and presentation.

3.14 'Evaluation' means every student shall be evaluated by in-semester assessment (20%) and end-semester assessment (80%).

3.15 'Improvement Examination' is an examination conducted to improve the performance of a student in the courses of a particular semester.

3.16 'Supplementary Examination' is an examination conducted for students who fail in the courses of a particular semester.

3.17 'Improvement Course' is a course registered by a student for improving the performance in that particular course.

3.18 'Supplementary Course' is a course that is repeated by a student for having failed in that course in an earlier registration.

3.19 'Credit' (C) of a course is a measure of the weekly unit of work assigned for that course in a semester.

3.20 One Credit would mean equivalent of 14 - 15 periods of 60 minutes each, for lectures, and tutorials. For workshops/labs and internship/field work, the credit weightage for equivalent hours shall be 50% of that for lectures/tutorials. For self-learning, based on e-content or otherwise, the credit weightage for equivalent hours of study should be 50% or less of for lectures/tutorials.

3.21 'Grade' means a letter symbol (A, B, C etc.) which indicates the broad level of performance of a student in a course/semester/programme.

3.22 'Grade Point' (GP) is the numerical indicator of the percentage of marks awarded to a student in a course.

3.23 'Credit Point' (CP) of a course is the value obtained by multiplying the grade point (GP) by the credit (C) of the course.

3.24 'Semester Grade Point Average' (SGPA) of a semester is calculated by dividing total credit points obtained by the student in a semester by total credits of that semester and shall be rounded off to two decimal places.

3.25 'Cumulative Grade Point Average' (CGPA) is the value obtained by dividing the sum of credit points in all the courses obtained by the student for the entire programme by the total credits of the whole programme and shall be rounded off to two decimal places.

3.26 'Institution average' is the value obtained by dividing the sum of the marks obtained by all students in a particular course by the number of students in respective course.

3.27 'Grace Marks' means marks awarded to course/courses as per the choice of the student, in recognition of meritorious achievements of a student in NCC/NSS/Sports/Arts and cultural activities.

3.28 First, Second, Third, Fourth and Fifth position shall be awarded to students who come in the first five places on the basis of overall marks in the programme in the first chance itself.

4. PROGRAMME STRUCTURE

4.1 The BVoc Programme shall include General Education components and Skill Components.

4.2 The credit distribution for the programme is shown below.

Normal Calendar Duration	Skill Component Credits	General Education Credits
One semester	18	12
Two Semesters	36	24
Four Semesters	72	48
Six Semesters	108	72

4.3 **Project, internship**

All students shall complete internships and one major project. The major project can be done individually or as a group of 5 students.

4.4 **Evaluations**

The evaluation of each course shall contain two parts.

i Internal or In-Semester Assessment (ISA)

ii External or End-Semester Assessment (ESA)

Both ISA and ESA shall be carried out using indirect grading. The ISA:ESA ratio shall be 1:4, for all courses including practical(practical courses will be treated as

independent courses). There shall be a maximum of eighty (80) marks for external evaluation and twenty (20) marks for internal evaluation.

4.5 **In-semester assessment of theory courses**

There are three components for ISA, which include attendance, assignment/seminar/viva-voce and in-semester examination. All the three components of the internal assessment are mandatory.

Components of ISA	Marks
Attendance	5
Assignment/Seminar/Viva	5
In-semester examination (2×5 = 10)	10
Total	**20**

Marks for attendance

% of Attendance	Marks
90 and above	5
85 - 89	4
80 - 84	3
76 - 79	2
75	1

(Decimals shall be rounded off to the next higher whole number)

In-semester examination

Every student shall undergo at least two in-semester examinations as class test as an internal component for theory courses.

4.6 **In-semester assessment of practical courses**

ISA - Components of Practical	Marks
Attendance	5
Record	5
Test	5
Performance, Punctuality and Skill	5
Total	**20**

4.7 To ensure transparency of the evaluation process, the ISA mark awarded to the students in each course in a semester shall be published on the notice board according to the schedule in the academic calendar published by the College. There shall not be any chance for improvement for ISA. The course teacher and the faculty mentor shall maintain the academic record of each student registered for the course which shall be forwarded to the office of the Controller of Examinations through the Head of the

Department and a copy should be kept in the office of the Head of the Department for at least two years for verification.

4.8 A student who has not secured minimum marks in internal examinations can redo the same before the end semester examination of the semester concerned.

4.9 **End-semester assessment**

The end-semester examination in theory and practical courses shall be conducted by the College.

4.10 The end-semester examinations shall be conducted at the end of each semester. There shall be one end-semester examination of three (3) hours duration in each lecture based course.

4.11 The question paper should be strictly on the basis of model question paper set by Board of Studies.

4.12 A question paper may contain very short answer type, short answer type, short essay type and long essay type questions. The question paper pattern is given below.

Section	Question Type	Number of Questions to be answered	Marks	Total marks
A	Very short answer type	9 out of 12	2	18
B	Short answer	6 out of 8	4	24
C	Short essay	3 out of 5	6	18
D	Long essay	2 out of 4	10	20
	Total	**20 out of 29**		**80**

4.13 Photocopies of the answer scripts of the external examination shall be made available to the students for scrutiny as per the regulations in the examination manual.

4.14 Practical examination shall be conducted in each semester. The duration and frequency of practical examination shall be decided by the respective Board of Studies.

4.15 Practical examination shall be conducted by one external examiner and one internal examiner. The question paper setting and evaluation of answer scripts shall be done as per the directions in the examination manual of the College.

4.16 **Project Evaluation**

The project report shall be subject to internal and external evaluation followed by a viva-voce at the end of the programme. Internal Evaluation is to be done by the supervising teacher and external evaluation by an external evaluation board consisting of an examiner appointed by the College and the Head of the Department or his nominee. A viva-voce related to the project work shall be conducted by the external evaluation board and students shall attend the viva-voce individually.

Components of Project Evaluation	Marks
Internal Evaluation	20
Dissertation (External)	50
Viva-Voce (External)	30
Total	**100**

4.18 If the student fails in project evaluation, he or she shall submit the project report after modifying it on the basis of the recommendations of the examiners.

4.19 **Evaluation of Internships**

All students shall submit a report on the internship. The internship shall be subject to internal and external evaluation. External evaluation shall be done by the agency where the student is doing the internship.

4.20 Assessment for the skill courses shall be done by an external agency to be arranged by the Rubber Skill Development Council (RSDC) and based on the assessment report certification of the successful students will be done by RSDC.

4.21 For all courses (theory and practical) an indirect grading system based on a seven (7) point scale according to the percentage of marks (ISA + ESA) is used to evaluate the performance of the student in that course. The percentage shall be rounded mathematically to the nearest whole number.

Percentage of Marks	Grade	Performance	Grade Point
95 and above	S	Outstanding	10
85 to below 95	A+	Excellent	9
75 to below 85	A	Very Good	8
65 to below 75	B+	Good	7
55 to below 65	B	Above Average	6
45 to below 55	C	Satisfactory	5
35 to below 45	D	Pass	4
Below 35	F	Failure	0

5. CREDIT POINT AND GRADE POINT AVERAGE

5.1. **Credit Point**

Credit Point (CP) of a course is calculated using the formula

CP = C × GP

where C is the credit and GP is the grade point

5.2. **Semester Grade Point Average**

Semester Grade Point Average (SGPA) is calculated using the formula

SGPA = TCP/TCS

where TCP is the total credit point of all the courses in the semester and TCS is the total credits in the semester

GPA shall be rounded off to two decimal places.

5.3. **Cumulative Grade Point Average**

Cumulative Grade Point Average (CGPA) is calculated using the formula

CGPA = TCP/TC

where TCP is the total credit point of all the courses in the whole programme and TC is the total credit in the whole programme

GPA shall be rounded off to two decimal places.

5.4 Grade Point Average (GPA) of different category of courses viz. Common Course I, Common Course II, Complementary Course I, Complementary Course II, Vocational Course, Core Course etc. are calculated using the formula

GPA = TCP/TC

where TCP is the Total Credit Point of a category of course and TC is the total credit of that category of course

Grades for the different courses, semesters, Semester Grade Point Average (SGPA) and grades for overall programme, Cumulative Grade Point Average (CGPA) are given based on the corresponding Grade Point Average (GPA) as shown below:

GPA	Grade	Performance
9.5 and above	S	Outstanding
8.5 to below 9.5	A+	Excellent
7.5 to below 8.5	A	Very Good
6.5 to below 7.5	B+	Good
5.5 to below 6.5	B	Above Average
4.5 to below 5.5	C	Satisfactory
3.5 to below 4.5	D	Pass
Below 3.5	F	Failure

5.5. A separate minimum of 30% marks each for internal and external (for both theory and practical) and aggregate minimum of 35% are required for a pass in a course.

5.6. For a pass in a programme, a separate minimum of grade 'D' is required for all the individual courses.

5.7. If a candidate secures F Grade for any one of the courses offered in a semester/programme, only F grade will be awarded for that semester/programme until the student improves this to D grade or above within the permitted period.

5.8. Candidate who secures D grade and above will be eligible for higher studies.

6 SUPPLEMENTARY/IMPROVEMENT EXAMINATION

There will be supplementary examinations and chance for improvement. Only one chance will be given for improving the marks of a course.

7 ATTENDANCE

7.1 The minimum requirement of aggregate attendance during a semester for appearing the end semester examination shall be 75%. Condonation of shortage of attendance to a maximum of ten (10) days or 50 hours in a semester subject to a maximum of two times during the whole period of undergraduate programme may be granted by the College.

7.2 If a student represents the College, University, State or Nation in Sports, NCC, NSS or Cultural or any other officially sponsored activities such as College union/University

union activities etc., he/she shall be eligible to claim the attendance for the actual number of days participated subject to a maximum of ten (10) days in a semester based on the specific recommendations of the Head of the Department.

7.3 A student who does not satisfy the requirements of attendance shall not be permitted to appear for the end-semester examinations.

7.4 Those students who are not eligible even with condonation of shortage of attendance shall repeat the course along with the next batch.

8 BOARD OF STUDIES AND COURSES

8.1 The Board of Studies in Chemistry shall design all the courses offered in the BVoc programme. The Board shall design and introduce new courses, modify or re-design existing courses and replace any existing courses with new/modified courses to facilitate better exposure and training for the students.

8.2 Each course shall have an alpha numeric code which includes abbreviation of the course in two letters, the semester number, code of the course and the serial number of the course.

8.3 Every Programme conducted under Credit Semester System shall be monitored by the Academic Council.

9 REGISTRATION

9.1 A student shall be permitted to register for the programme at the time of admission.

9.2 A student may be permitted to complete the programme, on valid reasons, within a period of twelve (12) continuous semesters from the date of commencement of the first semester of the programme.

9.3 Those students who possess the required minimum attendance and progress during an academic year/semester and could not register for the annual/semester examination in time are permitted to apply for Notional Registration to the examinations concerned enabling them to get promoted to the next semester.

10 ADMISSION

10.1 The admission to BVoc programme shall be as per the rules and regulations of the College/University.

10.2 The eligibility criteria for admission shall be as announced by the College/University from time to time.

10.3 Separate rank lists shall be drawn up for seats under reservation quota as per the existing rules.

10.4 There shall be a uniform academic and examination calendar prepared by the College for the conduct of the programmes.

11 ADMISSION REQUIREMENTS

11.1 Candidates for admission to the first semester of the BVoc programme through SB-CSS- BVoc shall be required to have passed Plus Two or equivalent examination or any other examination of any recognized authority, accepted by the Academic council of Mahatma Gandhi University as equivalent thereto.

11.2 Students admitted under this programme are governed by the Regulations in force.

12 PROMOTION

A student who registers his/her name for the external examination for a semester will be eligible for promotion to the next semester.

13 MARK CUM GRADE CARD

13.1 The College under its seal shall issue to the students, a Mark cum Grade card on completion of each semester, which shall contain the following information.

i. Name of the Student
ii. Register Number
iii. Photo of the student
iv. Degree
v. Programme
vi. Semester and Name of the Examination
vii. Month and Year of Examination
viii. Stream
ix. Course Code, Title and Credits of each course opted in the semester
x. Marks for ISA, ESA, Total Marks (ISA + ESA), Maximum Marks, Letter Grade, Grade Point (GP), Credit Point (CP) and Institution Average in each course opted in the semester
xi. Total Credits, Marks Awarded, Credit Point, SGPA and Letter Grade in the semester
xii. Result

13.2 The final Mark cum Grade Card issued at the end of the final semester shall contain the details of all courses taken during the entire programme including those taken over and above the prescribed minimum credits for obtaining the degree. The final Mark Cum Grade Card shall show the CGPA and the overall letter grade of a student for the entire programme.

14 AWARD OF DEGREE

The successful completion of all the courses with 'E' grade shall be the minimum requirement for the award of the degree. The certification levels will lead to Certificate/Diploma/Advanced Diploma/BVoc Degree in one or more vocational areas and will be offered under the aegis of the University. This is outlined in following table.

Award	Duration	Normal Calendar Duration	Corresponding NSQF level
Certificate	6 Months	One semester	4
Diploma	1 Year	Two Semesters	5
Advanced Diploma	2 Years	Four Semesters	6
BVoc Degree	3 Years	Six Semesters	7

Credit Transfer and Accumulation system can be adopted in the programme. Transfer of Credit consists of acknowledging, recognizing and accepting credits by an institution for programmes or courses completed at another institution. The Credit Transfer Scheme shall allow students pursuing a programme in one University to continue their education in another University without break.

15 MONITORING COMMITTEE

There shall be a Monitoring Committee constituted by the Principal to monitor the internal evaluation conducted by the College. The Course Teacher, Faculty Mentor, and the College Coordinator should keep all the records of the continuous evaluation, for at least a period of two years, for verification.

16 GRIEVANCE REDRESSAL MECHANISM

16.1 In order to address the grievance of students regarding ISA, a two-level Grievance Redressal mechanism is envisaged.

16.2 A student can approach the upper level only if grievance is not addressed at the lower level.

16.3 Department level: The Principal shall form a Grievance Redressal Committee in each Department comprising of course teacher and one senior teacher as members and the Head of the Department as Chairman. The Committee shall address all grievances relating to the internal assessment of the students.

16.4 College level: There shall be a College level Grievance Redressal Committee comprising of course teacher, two senior teachers and two staff council members (one shall be an elected member) and the Principal as Chairman. The Committee shall address all grievances relating to the internal assessment of the students.

17. TRANSITORY PROVISION

Notwithstanding anything contained in these regulations, the Principal shall, for a period of three years from the date of coming into force of these regulations, have the power to provide by order that these regulations shall be applied to any programme with such modifications as may be necessary.

PROGRAMME STRUCTURE

Semester I

Course Code	Title of the Course	G/S*	Instructional hours for the course	Credits	ISA	ESA	Total
BCENG101	English – I	G	56	4	20	80	100
BDMMG101	Mathematics – I	G	56	4	20	80	100
BBICG101	Foundations in Chemistry	G	56	4	20	80	100
	Junior Rubber Technician (NSQF Level - 4)						
BBICS101	Rubber Science and Technology - I	S	84	6	20	80	100
BBICS1P01	Rubber Science and Technology - I (P) (Industrial Training and Lab)	S	168	6	20	80	100
BBICS1IN01	Internship for Junior Rubber Technician	S	168	6	20	80	100
	Total			**30**	**120**	**480**	**600**

Total Credits: 30 Skill: 18 General: 12

Semester II

Course Code	Title of the Course	G/S*	Instructional hours for the course	Credits	ISA	ESA	Total
BCENG202	English – II	G	56	4	20	80	100
BDMMG202	Mathematics – II	G	56	4	20	80	100
BBICG202	Chemistry of the Environment	G	56	4	20	80	100
	Lab Chemist (NSQF Level - 5)						
BBICS202	Rubber Science and Technology - II Testing and Analysis of Rubber	S	84	6	20	80	100
BBICS2P02	Rubber Science and Technology - II Testing and Analysis of Rubber (P) (Industrial Training and Lab)	S	140	5	20	80	100
BBICS2IN02	Internship for Lab Chemist	S	196	7	20	80	100
	Total			**30**	**120**	**480**	**600**

Total Credits: 30 Skill: 18 General: 12

Semester III

Course Code	Title of the Course	G/S*	Instructional hours for the course	Credits	ISA	ESA	Total
BBICG303	Organic Chemistry – I	G	56	4	20	80	100
BBICG304	Organic Chemistry – II	G	56	4	20	80	100
BBICG305	Chemistry in Everyday Life	G	56	4	20	80	100
BBICS303	Polymer Chemistry	S	70	5	20	80	100
BBICS3P03	Polymer Chemistry Lab (P)	S	112	4	20	80	100
	Quality Assurance Supervisor (NSQF Level - 6)						
	Rubber Science and Technology - III	S	70	Evaluation in Semester IV			
	Quality Assurance Supervisor (P) (Industrial Training and Lab)	S	112				
	Total			**21**	**100**	**400**	**500**

Total Credits: 21 Skill: 9 General: 12

Semester IV

Course Code	Title of the Course	G/S*	Instructional hours for the course	Credits	ISA	ESA	Total
BBICG406	Physical Chemistry - I	G	56	4	20	80	100
BBICG407	Polymeric Elastomers	G	56	4	20	80	100
BBICG408	Polymer Technology	G	56	4	20	80	100
	Quality Assurance Supervisor (NSQF Level - 6)						
BBICS404	Rubber Science and Technology - III	S	84	11	20	80	100
BBICS4P04	Quality Assurance Supervisor (P) (Industrial Training and Lab)	S	140	9	20	80	100
BBICS4IN03	Internship for Quality Assurance Supervisor	S	196	7	20	80	100
	Total			**39**	**120**	**480**	**600**

Total Credits: 39 Skill: 27 General: 12

Semester V

Course Code	Title of the Course	G/S*	Instructional hours for the course	Credits	ISA	ESA	Total
BBICG509	Inorganic Chemistry	G	56	4	20	80	100
BBICG510	Environmental Toxicology	G	56	4	20	80	100
BBICG511	Advances in Chemistry	G	56	4	20	80	100
BBICS505	Modern Analytical Instrumentation	S	70	5	20	80	100
BBICS5P05	Environmental Chemistry Lab (P)	S	112	4	20	80	100
	Rubber Technologist (NSQF Level - 7)						
	Rubber Technology and Manufacture	S	70	Evaluation in Semester VI			
	Rubber Technology and Manufacture (P) (Industrial Training and Lab)	S	112				
	Total			**21**	**100**	**400**	**500**

Total Credits: 21 Skill: 9 General: 12

Semester VI

Course Code	Title of the Course	G/S*	Instructional hours for the course	Credits	ISA	ESA	Total
BBICG612	Physical Chemistry-II	G	56	4	20	80	100
BBICG613	Analytical Chemistry	G	56	4	20	80	100
BBICG614	Chemical Process Economics and Entrepreneurship	G	56	4	20	80	100
	Rubber Technologist (NSQF Level - 7)						
BBICS606	Rubber Technology and Manufacture	S	84	11	20	80	100
BBICS6P06	Rubber Technology and Manufacture (P) (Industrial Training and Lab)	S	140	9	20	80	100
BBICS6IN04	Internship for Rubber Technologist	S	140	5	20	80	100
BBICS6PJ	Project	S	56	2	20	80	100
	Total			**39**	**140**	**560**	**700**

Total Credits: 39 Skill: 27 General: 12

*G – General component
S – Skill component

GENERAL COMPONENTS

SEMESTER I

BCENG101: ENGLISH - I

Credits: 4 **Total Hours: 56**

Business, Social Skills and the Recruitment Process.

Each module is comprised of reading section, writing section, grammar and vocabulary. In addition to that each module is supplemented with activities which enable the student to practise what he/she has learnt.

Module-1

Greetings and Introduction (**10 hrs**)

Modes of greetings-samples of greetings-small talk-listening and speaking-

Reading comprehension

Related vocabulary

Grammar –contractions and negatives.

Activities

Module-2

Company profiles /jobs and responsibilities (**20 hrs**)

Business organisations-famous entrepreneurs –jobs and responsibilities-

Job profiles-job descriptions

Reading comprehension

Vocabulary related to business organisations, jobs and responsibilities.

Grammar: Wh------- Questions, verbs describing jobs and responsibilities.

Activities.

Module -3

Getting Ready for Job Market and organising a Portfolio. (**20 hrs**)

Organising a portfolio- self –profile making-web version of portfolio-presentation skill

Reading comprehension

Vocabulary for writing profiles

Grammar: present progressive tense.

Activities

Module-4

Responding to Advertisements (**10 hrs**)

Writing a CV and letter of application - making the sub heads in a CV-accepting and declining an Offer-responding to advertisements-

Reading comprehension

Vocabulary related to CV, application, advertisements, letter writing

Grammar: simple past tense

Activities

Reference Text: Business Communication, BCS-055, IGNOU, August 2013, ISBN: 978-81-266-6504-4

BDMMG101: MATHEMATICS - I

Credits: 4 **Total Hours: 56**

Module 1 **(15 hrs)**

Sets and Functions

Power set of a set, Product of two sets, Equivalence relations, partitions of sets, Equivalence classes Definition of a function. Domain, co- domain and the range of a function. Review of injective, surjective and bijective functions, Composition of functions. Invertible functions and the inverse of a function. Graphing of functions.

References:

1. Set Theory and Related Topics, Lip Schutz, Schaum Outline Series, 2009, 2nd Edition, Tata McGraw Hill Publishing Company, New Delhi.
2. Discrete Mathematics and its Applications, K. H. Rosen, 6th Edition, Tata McGraw Hill Publishing Company, New Delhi.

Module 2 **(15 hrs)**

Complex Numbers

Complex numbers. Addition and multiplication of complex numbers. Modulus, Real and imaginary parts, conjugate and amplitude of a complex number. Polar form of complex number. Geometric representation of the sum and difference.

References:

Fundamentals of Complex Analysis, E. B. Staff and A. D. Snider, 2009, 3rd Edition, Pearson Education.

Module 3 **(10 hrs)**

Limit, Continuity and Differentiability

Limits of Functions, calculating limits using the limit laws, one sided limits and limits at infinity, Continuity, Rates of change and Differentiability, standard results, Differentiation Rules, Chain Rule.

References:

Thomas' Calculus, George B. Thomas Jr., 2008, 11th Edition, Pearson. (Sections 2.1 to 2.6 and 3.1 to 3.2)

Module 4 **(16 hrs)**

Statistical Methods of Analysis

Types of data:- quantitative, qualitative. Classification and Tabulation. Diagrammatic representation:- Bar diagram, pie diagram; pictogram and cartogram. Graphical representation:- histogram; frequency polygon; frequency curve; ogives. Measures of Central Tendency:- Mean; Median; Mode; Geometric Mean; Harmonic Mean and Properties. Absolute and Relative measures of Dispersion:- Range, Quartile Deviation, Mean Deviation, Standard Deviation, Coefficient of Variation.

References:

1. S.P. Gupta: Statistical Methods (Sultan Chand & Sons Delhi).
2. S.C. Gupta and V.K. Kapoor: Fundamentals of Mathematical Statistics, Sultan Chand and Sons.
3. B.L. Agarwal: Basic Statistics, New Age International (p) Ltd.
4. Parimal Mukhopadhya: Mathematical Statistics, New Central Book Agency (p) Ltd, Calcutta
5. Murthy M.N.: Sampling theory and Methods, Statistical Publishing Society, Calcutta.

BBICG101: FOUNDATIONS IN CHEMISTRY

Credits: 4 **Total Hours: 56**

Module I: Methodology in chemistry (20 hrs)

General introduction – history and development of Chemistry – different branches of Chemistry – relevance of chemistry in everyday life. Applications in different fields - industry, agriculture, food, medicine, textile, building materials (paint, cement etc.), plastics, rubber, etc. Power generation by chemical methods such as fission and fusion reactions - solar cells, biofuel, feed stocks sugar/ starch/plant and animal fats biodiesel. Water-its unique features, hydrogen bonding etc. Mention about metals, non-metals and metalloids, combination of atoms. Different types of bonding (ionic, covalent, coordinate). Comparison of physical properties with chemistry. Organic Chemistry- Chemistry of Carbon compounds catenation – isomerism – vital force theory – purity of organic compounds. Classification – functional group – biomolecules – natural products –The concept of polymers, supramolecules and nanomaterials in chemistry.

Module II: Periodic classification (16 hrs)

Modern periodic law – long form periodic table – Periodicity in properties – Atomic, ionic, covalent radii – ionisation potential, electron affinity, Electronegativity – Paulings, Mulliken, Allred Rochow's Scale of electronegativity. Radius ratio – Effective nuclear change – Screening effect – Slater rules Anomalous behaviour of 1st element of a group – diagonal relationship.

Module III: Nuclear chemistry (20 hrs)

Natural radioactivity – Modes of decay – group displacement law – theories of disintegration – Rate of decay – Decay constant – Half-life period – Gieger Nuttal rule – Radioactive equilibrium – Disintegration series – Transmutation reactions – using protons, deutrons, α-particles and neutrons – Artificial radioactivity – Positron emission and K electron capture – Synthetic elements. Nuclear stability – N/P ratio – Packing fraction – Mass defect – binding energy – nuclear forces – exchange theory and nuclear fluid theory – Nuclear fission – fusion – hydrogen bomb – atomic bomb – nuclear reactor. Isotopes – detection – Aston's mass spectrograph – separation of isotopes – Gaseous diffusion method – thermal diffusion method

– Application of radioactive isotopes – 14C dating – rock dating – isotopes as tracers – study of reaction mechanism (ester hydrolysis) – Radio diagnosis and radiotherapy.

References

1. Gieryn T. F, Cultural Boundaries of Science, Univ. Chicago Press 1999.
2. Collins H and T. Pinch, The Golem What Everyone Should Know About Science, Cambridge University Press,1993.
3. Hewitt, Paul G, Suzanne Lyons, John A Suchocki and Jennifer Yeh, Conceptual Integrated Science, Addison – Wesley, 2007.
4. Jeffrey A Lee, The Scientific Endeavour: A Premier on Scientific Principles and Practice, Pearson Education.
5. Rao C N R, Understanding Chemistry, University Press (India) Pvt. Ltd.
6. Puri, Sharma & Kalia, Principles of Inorganic Chemistry, Milestone Publishers and Distributors, 2008.

SEMESTER II

BCENG202: ENGLISH - II

Credits: 4 **Total Hours: 56**

Finishing Skills for Interviews and Placement

Module-1 Preparing for interviews (**10 hrs**)

Listening comprehension

Reading comprehension

Vocabulary and structure of CV

Grammar: Modals indicating obligation, prefixes

Activities

Module -2 Facing interviews (**10 hrs**)

Reading comprehension

Listening comprehension

STAR Structure

Body language

Vocabulary

Grammar: Passive

Activities

Module-3 Phone and Walk in Interviews (**12 hrs**)

Types of interviews

Preparation for interviews

Listening comprehension

Reading comprehension

Vocabulary related to interviews

Grammar: Articles (A/AN/THE)

Activities

Module-4 Group Discussion (**12 hrs**)

Group discussion types-formalities in GD-

Listening comprehension

Reading comprehension

Do’s and don’ts in a GD

Vocabulary related to GD

Grammar: Non-finite verbs (the participle)

Activities

Module -5 Practice and Training (12 hrs)

Mock interview, C V making, GD, and computer skills in M S Word

Reference Text: Interviews, IGNOU, August 2013, ISBN: 978-81-266-6531-0

BDMMG202: MATHEMATICS - II

Credits: 4 **Total Hours: 56**

Module 1 (15hrs)

Applications of Derivatives:

Extreme values of functions, The Mean Value Theorem, Monotonic functions and the first derivative test. (Proofs Excluded)

Reference

Thomas' Calculus, George B. Thomas Jr., 2008, 11th Edition, Pearson. (Sections 4.1 to 4.3)

Module 2 (15hrs)

Partial Derivatives:

Functions of several variables (Definition only), Partial derivatives, The Chain Rule.

Reference

Thomas' Calculus, George B. Thomas Jr., 2008, 11th Edition, Pearson. (Sections 14.3 to 14.4)

Module 3 (10hrs)

Theory of Matrices:

Definition, Types of Matrices, Operations on Matrices, Transpose of a Matrix, Elementary Transformations of a Matrix, Invertible Matrices, Finding Rank and Inverse of a Matrix using elementary row transformations.

References:

1. Matrices: Schaum's Outline Series, Frank Ayres Jr., TMH Edition.
2. A Text Book of Matrices, Shanthi Narayanan and P. K. Mittal, S. Chand Publications.
3. Matrix Theory, David W. Lewis, Allied Publications.

Module 4 (20hrs)

Numerical Analysis:

Bisection Method, Method of False Position, Iteration Method, Newton-Raphson Method.

References:

Introductory Methods of Numerical Analysis, S. S. Sastry, 4th Edition, PHI (Sections 2.2 to 2.5)

BBICG202: CHEMISTRY OF THE ENVIRONMENT

Credits: 4 **Total Hours: 56**

Module I: Introduction to environmental chemistry (**14 hrs**)

Concept and scope of environmental chemistry, branches of environmental chemistry, fundamental of environmental chemistry, stoichiometry, Gibbs energy, Chemical potential, chemical equilibria, acid base reactions, solubility products, solubility of gases in water, the carbonate system, unsaturated and saturated hydrocarbons.

Module II: Atmospheric chemistry (**14 hrs**)

Structure of chemical composition of air, classification of elements, chemical speciation, particles, ions and radicals in atmosphere, chemical processes for formation of organic and inorganic particles, chemistry of air pollutants, photochemical reactions in atmosphere , oxygen and ozone chemistry, greenhouse gases and greenhouse effect, global warming, El-Nino, La-Nina, Earths radiation balance, Temperature inversion, Acid rain, photochemical smog.

Module III: Hydrochemistry (**14hrs**)

Introduction to hydrochemistry of water, chemical composition of water samples, structure and bonding of water, formation of hydrogen bonding, structure of ice, auto ionization, atmospheric nature, electrolysis of water, reactivity of water towards alkaline earth metals, Solubility of gases in water, Complexation in natural water and waste water, eutrophication.

Module IV: Soil chemistry (**14 hrs**)

Introduction to soil chemistry, chemical composition of lithosphere and soil, chemistry of soil formation, sorption and precipitation reaction in soil, oxidation and reduction reaction in soil, anion and cation exchange capacity, soil pH.

Tools and techniques in environmental chemistry: Principles of analytical methods, Titrimetry, gravimetry, colorimetry, spectro photometry, chromatography, atomic absorption spectroscopy, chromatography, TLC-paper and ion-exchange electrophoresis, X-ray fluorescence, flame photometry, complexometric titrations, and principles of photochemistry.

References

1. Trivedi P.R & Raj Gurdeo - Environmental water and soil Analysis Akasdeep Pub. House, New Delhi.
2. V.K. Alhuwalia, Environmental Chemistry, Ane books Pvt. Ltd, Chennai
3. S.P. Misra and S.N. Pandey – Essential Environmental studies – Ane Books Pvt. Ltd.
4. P.L. Soni - Physical Chemistry
5. B.K Sharma – Environmental chemistry –Goel publication.
6. A.K. De - Environmental Chemistry
7. Tyagi and Mehra - Environmental Chemistry

SEMESTER III

BBICG303: ORGANIC CHEMISTRY - I

Credits: 4 **Total Hours: 56**

Module I: Hydrocarbon (14 hrs)

Structure and Bonding of alkanes. Hybridisation and shapes of simple molecules –methane, ethane, ethylene, acetylene – polarity of bonds – Inductive effect, electromeric effect, hyperconjugation, resonance, steric effect – rules for resonance forms and techniques of drawing resonance forms – curved arrow formalism – nomenclature of alkanes – source of hydrocarbons – methods of formation – Wurtz reaction, Kolbe reaction, Corey-House reaction and decarboxylation – Properties of alkanes – oxidation and chlorination.

Module II: Introduction to organic reaction mechanisms (14 hrs)

Hydrocarbons III: Nomenclature – industrial preparation and uses of alkenes – calculation of degree of unsaturation – cis-trans isomerisms – E-Z designation – electrophilic addition reaction – mechanism of addition of hydrogen halides and halogen to alkenes – Markownikoff's rule – Peroxide effect – mechanisms. Synthesis from alcohols and alkyl halides.

Module III: Stereochemistry (14 hrs)

Critical activity – Specific rotation and enantiomeric excess – chirality and elements of symmetry – enantiomers –diastereomers – lactic acid, glyceraldehyde - tartaric acid aldotetroses- DL and R-S configurations. Meso compounds – Racemic mixtures and resolution – optical isomerism of compounds without asymmetric carbon atoms – Allenes and biphenyls – asymmetric synthesis.

Module IV: Benzene and aromaticity (14 hrs)

Nomenclature – structure and stability of benzene – molecular orbital description – Aromaticity and Huckel's rule – Naphthalene, Anthracene – Haworth synthesis of naphthalene. Reactions of benzene. Electrophilic substitution reactions with mechanism – Halogenation, nitration, sulphonation, Friedel-Craft's reaction orientation effect of substituents – Nitration and sulphonation of naphthalenes with mechanism. Oxidation and

reduction of aromatic compounds – side chain oxidation, catalytic hydrogenation of aromatic rings.

References

1. John McMurry – Fundamental of Organic Chemistry, Brook and Cole.
2. Bruice – Organic Chemistry, Pearson Education, New Series 2001, 3rd Edition.
3. Mark Louden – Organic Chemistry, Oxford University Press, Oxford.
4. L.G. Wade, J.R., Organic Chemistry, Pearson Education, Singapore, 2004, Vth Edn.
5. Solomons & Fryhle, Organic Chemistry, Wiley India Pvt. Ltd., 2004, VIIthEdn.
6. I.L. Finar, Organic Chemistry, Vol. I & II, ELBS with Longman, Singapore, 1973, VIth Edition.
7. Morrison & Boyd, Organic Chemistry, Prentice Hall of India Pvt. Ltd., New Delhi, 1998, VI Edn.
8. Bhal & Mehrothra, Vikas & Vishno, Textbook of Organic Chemistry.
9. M.K. Jain, Principles of Organic Chemistry.

BBICG304: ORGANIC CHEMISTRY -II

Credits: 4 **Total Hours: 56**

Unit I: Alkynes, Alkyl Halides and Polyhalogen Compounds (14 hrs)

Alkynes: preparation, mechanism of dehydrohalogenation and dehydrogenation. Reactions: acidity of alkynes, formation of acetylides, mechanism of addition of water, hydrogen halides and halogens, oxidation, ozonolysis and hydroboration/oxidation. Alkyl halides: nomenclature and classes of alkyl halides, methods of formation, chemical reactions. Mechanisms of nucleophilic substitution reactions of alkyl halides, SN^2 and $SN^1$with energy profile diagrams. Effect of solvent, substrate, nucleophile, nucleofuge, neighbouring group participation. SN^i mechanism with examples. Methods of formation of aryl halides, nuclear and side chain reactions. The addition -elimination and the elimination -addition mechanisms of nucleophilic aromatic substitution reactions. Relative reactivities of alkyl halides vs. allyl, vinyl and aryl halides. Synthesis and uses of DDT and BHC. Polyhalogen compounds: chloroform and carbon tetrachloride -preparation, reactions and uses. Grignard reagents: preparation, structure and synthetic applications, alkyl lithium compounds.

Unit II: Alcohols, Phenols and Ethers (14 hrs)

Aliphatic alcohols: preparation by hydroboration, oxidation, reduction of carbonyl compounds, epoxidation, fermentation of carbohydrates and Grignard synthesis. Reactions with reference to C-OH bond cleavage and O-H bond cleavage, iodoform test. Ascent and descent in alcohol series. Dihydric and trihydric alcohols: reactions with lead tetra acetate and periodic acid. Pinacol-pinacolone rearrangement. Alcoholic beverages. Phenols: nomenclature, physical properties, hydrogen bonding. Preparation: Industrial source, preparation from diazonium salts and sulphonic acids. Reactions: acidity, ether formation, ester formation, mechanism of ring substitution, nitration, sulphonation, halogenation, Friedel Craft's reaction, nitrosation, coupling reactions, Kolbe's reaction and Riemer -Tiemann reaction. Lederer -Manase reaction, Fries rearrangement. Preparation and uses of nitrophenols, picric acid, catechol, resorcinol, quinol and naphthols. Ethers and epoxides: nomenclature and classification. Preparation by Williamson's synthesis and alkoxymercuration -demercuration methods. Reactions: cleavage by acids. Preparation and reactions of epoxides. Preparation and reactions of thiols and thioethers.

Unit III-Aldehydes and Ketones (14 hrs)

Aldehydes and ketones: nomenclature and classification. Preparation of aldehydes and ketones. Reactivity of carbonyl groups, acidity of alpha hydrogen. Reactions: mechanism of enolization reactions, nucleophilic addition, oxidation and reduction reactions, addition reactions with Grignard reagents, cyanide, and bisulphate, preparation of derivatives of ammonia and alcohols. Mechanism of aldol, Perkin, Knoevenagel reactions and benzoin condensation, Claisen, Wittig, Cannizarro, Beckmann, benzyl -benzilic acid rearrangement and Reformatsky reactions. Mechanism of reductions with $NaBH_4$, $LiAlH_4$, Active methylene compounds: keto-enol tautomerism. Preparation and synthetic applications of diethyl malonate and ethyl acetoacetate.

Unit IV: Heterocyclic Compounds and Natural Products (14 hrs)

Classification: five membered ring compounds: Preparation of furan, pyrrole and thiophene. Reactions: electrophilic and nucleophilic substitutions, oxidation and reduction reactions. Six membered rings: synthesis of pyridine, piperidine, quinoline and isoquinoline:

Preparation by ring closing reactions. Reactions: mechanism of electrophilic and nucleophilic substitutions, oxidation and reduction reactions. Basicity of heterocyclic compounds in comparison with amines. Synthesis of indole (Skraup's method, Bishler-Napieralski and Fischer -Indole synthesis).Alkaloids: definition, occurrence, extraction of alkaloids from plants, general properties. Structural elucidation of coniine, piperine and nicotine.Terpenoids: classification, isoprene rule, isolation and general properties. Occurrence, general structure and physical properties of geraniol, citral, menthol, α-pinene and camphor. Structural elucidation of citral and geraniol.

Reference

1. I. L. Finar, Organic Chemistry, Vols. 1 & 2, 5th Edn., Pearson Education, 2005
2. V. K. Ahluwalia, Green Chemistry: Environmentally Benign Reactions, 2ndEdn.,Ane Books India, 2013
3. P. Sykes, A guide to mechanism in Organic Chemistry, 6thEdn., Pearson Education, 2004
4. P. S. Kalsi, Organic Reactions and Their Mechanisms,8th Edn.,New Age International, 2014
5. J. March, Advanced Organic Chemistry, 6th Edn., John Wiley & Sons, 2007

1. 6.J. Clayden, N. Greeves,S. Warren, Organic Chemistry, 7thEdn., Oxford University Press, 2012
6. R. T. Morrison and R. N. Boyd, Organic Chemistry, 6thEdn., Prentice–Hall, 2004
7. K. S. Tewari and N.K. Vishnoi, Organic Chemistry, 3rdEdn.,Vikas Publishing House
8. M. K. Jain and S. C. Sharma, Modern Organic Chemistry, 3rdEdn., Vishal Publishing Company
9. S. M. Mukherji and S. P. Singh, Reaction Mechanism in Organic Chemistry, Macmillan, 1984
10. Arun Bahl and B. S. Bahl Advanced Organic Chemistry, S. Chand Publishers

BBICG305: CHEMISTRY IN EVERYDAY LIFE

Credits: 4 **Total Hours: 56**

Module I: Soaps, detergents and detergent builders-preparation. Difference between soap and detergents. Cleansing action of soaps and detergents. Soaps and detergents as pollutants. Shampoo and toilet soap preparation **(10 hrs)**

Module II: Food poisoning-food poisoning caused by chemicals, poisonous plants and microorganisms, Food hygiene in the prevention of food poisoning chemicals, poisonous plants and microorganisms, Food hygiene in the prevention of food poisoning**. (10 hrs)**

Module III: Green Chemistry-Principles of Green Chemistry, Design of Green Synthesis, prevention of waste and byproducts, Atom Economy, prevention of chemical accidents, microwave assisted green synthesis, Diels Alder reaction. **(16 hrs)**

Module IV: Water Analysis-Water quality monitoring-sampling-analysis of water-physicochemical and biological parameters of water-water quality standards-WHO, BIS-Eutrophication. **(10 hrs)**

Module V: Environmental Issues - Global warming and Green House Effect-Acid Rain-Bhopal Tragedy. Environmental movements-Plachimada movement-Silent Valley, Narmada Bachao Andolan, Chipko movement. **(10 hrs)**

References

1. Ahuluwalia V.K. Green Chemistry
2. Ahuluwalia V.K. and M. Kidwai. New trends in Green Chemistry
3. Misra, S.P. and S.N. Pandey, Essential Environmental Studies, 2009, Ane Books Pvt. Ltd.
4. Bhatia, S.C, Environmental Chemistry, CBS publications
5. De A.K. Environmental Chemistry
6. Bharucha, E. Text Book of Environmental Chemistry, Oxford & IBH
7. Ahuluwalia V.K. and SunitaMalhotra, Environmental Science, Ane Books Pvt. Ltd

SEMESTER IV

BBICG406: PHYSICAL CHEMISTRY - I

Credits: 4 **Total Hours: 56**

Module I: Electrochemistry (14 hrs)

Farday's laws – applications – Measurement of conductance – Specific and molar conductance – Arrhenius theory of electrolytic dissociation – Ostwald's dilution law – Variation of conductance with dilution –Applications of conductance measurements – Determination of degree of dissociation. Ionic product of water – solubility of sparingly soluble salts – conductometric titrations.

Electrochemical Cells: types of electrochemical cells and examples, emf and change in free energy, Nernst equation. Standard cells, half cells/electrodes, different types of electrodes (with examples). Standard electrode potential (IUPAC convention) Potentiometric titrations: acid - base and redox. Rules of oxidation/reduction of ions based on half-cell potentials.

Potentiometry: Potentiometric titrations-types and applications.

Polarography, applications of polarography.

Module II: Liquid state (14 hrs)

Vapour pressure – determination of V.P. Surface Tension – determination – Parachar – determination application to structure elucidation of compounds viscosity – determination of molecular mass from viscosity measurements – refraction – refractive index – molar refraction and optical exaltation – application to structure elucidation.

Module III: Thermodynamics (14 hrs)

Definition of thermodynamic terms – types of systems – intensive and extensive properties – State and path functions – Zeroth law of thermodynamics. First law of thermodynamics – concept of heat, work, internal energy and enthalpy – heat capacity relation between Cp and Cv, Joule - Thomson effect, Inversion temperature.

Second law of thermodynamics – Limitations of first law and need for second law – different statements of the law. Concept of entropy – Entropy changes in isothermal expansion of an ideal gas– Entropy changes in phase changes – Calculation of entropy change of an ideal gas

with change in P, V and T. Work and free energy functions –Criteria for reversible and irreversible processes.

Module IV: Ionic equilibrium (14 hrs)

Theories of acids and bases: Arrhenius, Lowry-Bronsted and Lewis theories – Levelling and differentiating solvents – pKa, pKb and pH.Applications of common ion effect and solubility product – Hydrolysis of salts of all types. Buffer solutions – Mechanism of buffer action, buffer index – Henderson equation.

Reference

1. B. R. Puri, L. R Sharma and M. S. Pathania, Principles of Physical Chemistry, Vishal Publishing Company, Jalandhar, 2010
2. K. L. Kapoor, Physical Chemistry, Vol. I, II, III & IV, Mac Millan (India) Ltd., 2000
3. P. Atkins and J. de Paula, Atkin's Physical Chemistry, 7thEdn., Oxford University Press, 2006
4. F. A. Alberty and R. J. Silby, Physical Chemistry, 3rd Edn., John Wiley & Sons, 2004
5. J. Rajaram and J. C. Kuriakose, Thermodynamics, Shobanlal Nagin Chand & Co.,1986
6. G. K. Vemulapalli, Physical Chemistry, Prentice Hall of India Pvt. Ltd., 1997

BBICG407: POLYMERIC ELASTOMERS

Credits: 4 **Total Hours: 56**

Module I: General purpose rubbers (20 hrs)

Introduction to latices, classification of latices, comparisons and contrasts between polymer latices and polymer solutions, investigation of latex properties-TSC, DRC, pH, alkalinity, colloidal stability, KOH number, VFA, surface free energy, density, residues. Preservation and concentration of natural rubber latex, types of dipping processes, Dunlop process.

Natural rubber latex –conversion to dry rubber - grading and specifications of NR – chemically modified NR – SBR – preparation – types and properties – BR – polymerization – IR – vulcanization of general purpose rubbers - polyalkenamers, polynorbornenes –reclaimed rubbers – other recycling methods for rubbers.

Module II: Polyurethanes and thermoplastic rubbers (16 hrs)

SBS, PU, polyamide and polyester based TPEs, plasticized PVC, castable and millable rubbers based on PU – processing advantages of PUs in foams, RIM products.

Module III: Vulcanisation agents and additives (20 hrs)

Vulcanising agents – sulphur, peroxides, phenolic resins, metal oxides, amines, urethane cure, etc - accelerators – activators- PVI, retarders, coagents etc.

Fillers – carbon black-their preparation, reinforcement mechanism, characteristics, non- black fillers, antioxidants and anti ozonants, colorants, processing aids – reclaimed rubbers.

References

1. FrantaI; Elastomers and Rubber Compounding materials, Elsevier, 1989.
2. Morton, M., Rubber Technology, Chapman Hall, 1995.
3. Dick J.S., Rubber Technology Compounding and Testing FOR Performance, Hanser Publisher, 2001.

BBICG408: POLYMER TECHNOLOGY

Credits: 4 **Total Hours: 56**

Module I: **(14 hrs)**

Additives for compounding plastics, fillers, plasticizers and softeners, lubricants and flow promoters, antiaging additives, flame retarders, colorants, blowing agents, UV stabilizers, requirement and functions of each ingredient.

Module II: **(14 hrs)**

Compounding ingredients for rubber: fillers-reinforcing, semi reinforcing and non-reinforcing, peptizers, vulcanizing agents, activators, accelerators, anti-oxidants, antiozonants, pigments, tackifiers, blowing agents, bonding agents and processing aids. Vulcanization of rubber, types of vulcanisation, rheograph, cure time, scorch time.

Module III: **(14 hrs)**

Compound development-formulation of mixes, compounding for specific applications, ozone resistance, heat resistance, weather, oil and radiation resistance, impermeability, medical application, low temperature properties, electrical and optical applications.

Module IV: **(14 hrs)**

Processing methods for the manufacture of products with dry rubber-blending and mastication, master batching of polymers, mixing and compounding in mills and internal mixers, calendaring, sheeting, fabric coating, extension, moulding, batch curing, cold curing, continuous vulcanization methods-high pressure steam, hot air tunnel, molten salt bath, fluidized bed, continuous drum care and microwave curing.

References

1. B.R. Gupta, Applied Rheology in Polymer Processing, Asian Books, 2005.
2. James L. White, “Rubber Processing” Hanser Publishers, 1995.
3. Anil K. Bhowmick et al, Rubber Products Manufacturing Technology, Marcel Dekker, 1994.
4. John S Dick, Rubber Technology, Hanser 2001.
5. Kleemann and Weber, Elastomer Processing, Hanser 1998

6. James E mark et al., Science and technology of rubber, Elsevier, 2005.
7. Richard F. Grossman, The Mixing of Rubber, Chapman & Hall, 1997.

SEMESTER V

BBICG509: INORGANIC CHEMISTRY

Credits: 4 **Total Hours: 56**

Module I: Atomic structure **(14 hrs)**

Bohr model of hydrogen atom, Bohr's equation for the energy of electron in hydrogen atom, the hydrogen spectrum, limitations of Bohr theory, photoelectric effect, idea of de Broglie matter waves, Heisenberg's uncertainty principle and its significance, Schrodinger wave equation (derivation not expected), wave functions, significance of ψ (psi) and ψ^2, atomic orbitals, Nodal planes in atomic orbitals, quantum numbers (n, l, m), Zeeman effect, Stern-Gerlac experiment, spin quantum number (s), shapes of s, p and d orbitals. Aufbau and Pauli's exclusion principles, Hund's rule, energy level diagram of a multi electron atom, concept of effective nuclear charge, Slater's rules and applications, Electronic configuration of atoms.

Module II: Chemical bonding **(14 hrs)**

Ionic bond – Lattice energy of ionic compounds - Born-Lande equation – Born-Haber cycle – its applications – Lattice energy – solubility – polarisation of ions – Fajan's rules.

Covalent bond: Valance bond theory – hybridisation – sp, sp^2, sp^3, sp^3d and sp^3d^2hybridisations – structure of molecules – H_2O, NH_3, XeF_2, XeF_4, SF_4, ClF_3, IF_7, I_3, SO_4^{2-}.Polarity of covalent bond – percentage of ionic character – dipole moment and molecular structure.

Module III: Representative elements **(14 hrs)**

General characteristics of S block elements – electronic configuration, size, density, ionisation energy, melting point, boiling point, flame colour. General characteristics of P block elements – Electronic configuration, size, oxidation state, ionisation energy, electron affinity, electronegativity. Preparation, properties and structure of diborane, borazine, boric acid, boron nitride and interhalogen compounds (ClF, ICl_3, ClF_3, IF_5 and IF_7).Electropositive character of iodine– separation of noble gases (charcoal adsorption method).

Module IV: Metallurgy **(14 hrs)**

Occurrence of metals based on standard electrode potential – concentration of ores – calcination, roasting and smelting – reduction using carbon and other reducing agents – electrolytic reduction – hydrometallurgy – Ellinmgham diagram. Reforming of metals – electrolytic refining – oxidative refining – zone refining – Van Arkel method. Extractive metallurgy of Li, Ni, Ti and U – Ferrous metallurgy – manufacture of steel by open hearth process – Alloys – types.

References

1. J. E. Huheey, E. A. Keiter and R. L. Keiter, Inorganic Chemistry: Principles of Structure and Reactivity, 4thEdn., Pearson Education, 2006
2. J. D. Lee, Concise Inorganic Chemistry, 5thEdn., Chapman & Hall, 2002
3. D. F. Shriver and P. W. Atkins, Inorganic Chemistry, 3rdEdn., Oxford University Press, New Delhi, 2004
4. F. A. Cotton. and G. Wilkinson, Advanced Inorganic Chemistry, 1st - 6thEdns., Wiley Interscience, 1962, 1966, 1972, 1980, 1988, 1999
5. Manas Chanda, Atomic Structure and Chemical Bonding, Tata McGraw Hill, 2007
6. B. R. Puri, L. R. Sharma and K. C. Kalia, Principles of Inorganic Chemistry, Vikas Publishing Co., Jalandhar 2013
7. R. Gopal, Inorganic Chemistry for Undergraduates, Universities Press, India Pvt. Ltd., 2009
8. P. L. Soni, Text book of Inorganic Chemistry, S. Chand and Sons, 2007

BBICG510: ENVIRONMENTAL TOXICOLOGY

Credits: 4 **Total Hours: 56**

Module I: Introduction to toxicology (14 hrs)

Concept of toxins, toxicity and toxicology, sub disciplines of toxicology - Environmental toxicology, aquatic toxicology, forensic toxicology, chemical toxicology, toxicogenomix. Types of toxicants, classification of toxicants – factors that affect environmental concentration of toxicants.

Module II: Toxic chemicals in the environment (14 hrs)

Toxic chemicals in air: Acid fumes – SO_2, NO_x, H_2S, particulate matter, ozone, Hydrocarbons, Dioxins and Heavy metals (mention only).

Toxic chemicals in water Industrial chemicals, agro chemical and fertilizers – Ammonium sulphate, potash, urea, pesticides – organochlorines (DDT, BHC, Endosulphan), organophosphates (Malathion, Parathion) and carbamates (Carbaryl, Timet) persistent organic pollutants (POP's). Radioactive materials

Toxic chemicals on land: Urban waste, biodegradable and non-biodegradable materials, fly ash, E –waste etc.

Module III: Biological concept for behaviour of pollutants (14 hrs)

Biotransformation, bio magnification, bio concentration, bio accumulation, bio activation, substance that magnify in biological system- POP's (DDT, PCBs, Toxaphene etc.)Heavy metals (Mercury, Arsenic, Lead, Cadmium etc.)

Module VI: Food adulteration (14 hrs)

Common adulterants, Intentional and incidental adulteration, Methods for detection of food adulterant. Safety of food additives and preservatives. Food additive regulations, Food grades, Food standards, food laws and food regulations.

References

1. Jacob, Thankamma, Food Adulteration, MC Millan Publishers Pvt. Ltd., 1976.
2. Kalia M &Sood. Food preservation and processing, Kalyani Publishers. Ludhiana, New Delhi.

3. A.K. De – Environmental Chemistry
4. B.K. Sharma and H. Kans Environmental Chemistry
5. P.D. Sharma, Environmental Biology and Toxicology, 1997-98.
6. P.K. Gupta and D.K. Shinlee, Modern Toxicology
7. Hobbs B.C & Roberts D. Food poisoning and Food Hygeine 6th Edi. Arnold Publishers London, 1993.
8. G.C. Butler, Principles of Eco Toxicology
9. Duffus, John H, Environmental Toxicology
10. Shukla J.P and Pandey, Elements of Toxicology, Radha Publishers, New Delhi.
11. Rand G.M and Perocelli S.R, Fundamental of Aquatic Toxicology, Hemisphere Publishing Corporation, Washington.
12. Cockerham L.G and Shane B.S, Basic Environmental Toxicology, CRC Press, Bocaraton,

BBICG511: ADVANCES IN CHEMISTRY

Credits: 4 **Total Hours: 56**

Module I: Nanochemistry (20 hrs)

Introduction – Quantum structures – Nanostructures – synthesis and properties of carbon nanostructures – Inorganic nanotubes and nanowires – Oxide nanoparticles – nanocomposites and nanofibers. Applications of nanotechnology in catalysis, biology, nanofilters, nanoswitches. Image application, writing with atoms – computing and electronics.

Module II: Green chemistry (20 hrs)

Need for Green chemistry – Goals of green chemistry – Limitations. Twelve principles of green chemistry with their explanations and examples – Designing a green synthesis – Prevention of waste / byproducts – Atom economy (maximum incorporation of materials used in the process) – Minimization of hazardous / toxic products – prevention of chemical accidents – Green synthesis – Ibuprofen.

Module IV: Catalyst manufacture (16 hrs)

Scope and goals – catalysts prepared by precipitation – solution and slurry transfer – filtration – drying: calcining; ion exchange; pulverization, pilling and extrusion; crushing and screening to produce granules; coating (not impregnation); impregnation to orient the coating material to the support – anchor coating or wash coating.

References

1. V. Kumar, Introduction to Green Chemistry, Vishal Publishing House.
2. R.W. Dyson, Speciality Polymers, Chapman and Hall, 1987.
3. J.I. Kroschwitz, Encyclopedia of Polymer Science and Engineering Vol.10, Wiley, 1990.
4. A.H. Frazer, High Temperature Resistant Polymers, Interscience, 1968.
5. J.A. Brydson, Plastic Materials, Butterworths-Hieneman, 1999.
6. G. Ertl, H. Knozinger and J. Weitkamp (eds), Preparation of Solid Catalysts, Wiley VCH, Verlag, 1999.
7. A.B. Stiles and T.A. Koch, “Catalyst manufacture”, Marcel Dekker Inc., NY, 1995.

SEMESTER VI

BBICG612: PHYSICAL CHEMISTRY – II

Credits: 4 **Total Hours: 56**

Module I: Solid state **(14 hrs)**

Law of constancy of interfacial angles – Law of constancy of symmetry – Law of rationality of indices – space lattice and unit cell – Miller indices – seven crystal systems and fourteen Bravais lattices. X ray diffraction – Bragg's equation. Brief description of rotating crystal method and powder method. Analysis of powder diffraction patterns of NaCl, CoCl and KCl. Close packing of spheres – packing of spheres in body centred cubic arrangement – Structure of ionic compounds of the type AX (NaCl, CsCl, ZnS), AX_2 (CaF_2 TiO_2). Defects of crystals. Non-stoichiometric and stoichiometric defects. Point defects, Shotky defect and Frenkel defects Extrinsic and intrinsic conduction – Liquid crystals classification and its applications (Theory not required).

Module II: Solutions **(14 hrs)**

Kinds of solutions and methods for expressing concentration – Molarity, molality, mole fraction, normality, mass fraction, parts per million – Ideal solutions – Raoult's law. Solubility of gases in liquids – Henry's law. Pressure – composition and temperature – Composition diagrams – deviation from ideal behaviour for completely miscible liquid systems – Fractional distillation – Colligative properties – Relation between Colligative properties and Molecular mass (Thermodynamic derivation not needed). Abnormal molecular mass – Vant Hoff factor.

Module III: Phase equilibrium **(14 hrs)**

Phase rule Equilibrium between phases. One component systems – Water system and sulphur system – Two component systems – Simple eutectic systems – Lead silver system, KI water system – Freezing mixtures. congruent and incongruent melting points –

Liquid-liquid-equilibrium – partially miscible and immiscible liquid systems – CST – upper CST and lower CST – Steam distillation – Distribution law and– Applications.

Module IV: Surface chemistry and adsorption (14 hrs)

Physical and chemical adsorption – Adsorption isotherms – Langmuir Fruendlich and B.E.T. equations (B.E.T. no derivation) – Gibbs adsorption equation – Surface films –Determination of surface area using Langmuir and B.E.T. equations.

Colloids: Types and classification – preparation of colloids – purification – protective colloids – kinetic, optical and electrical properties – surfactants – Gels – Emulsions. Properties and applications. Zeta potential Donnan membrane equilibrium – Dorn effect.

References

1. B.R. Puri, L.R. Sharma & M.S. Pathania, Principles of Physical Chemistry, Vishal Publishing Co., Jalandhar.
2. P.L. Soni, O.P. Dharmarha & U.N. Dash, Text book of Physical Chemistry, 22nd Edn., Sultan Chand & Sons, New Delhi.
3. L.V. Azaroff, Introduction to Solids, McGraw Hill.
4. N.B. Hanna, Solid Chemistry, Prentice Hall.
5. Colin N. Banwell & E.M. McCash, Fundamental State of Molecular Spectroscopy, Tata McGraw Hill Publishing Company Ltd., New Delhi.
6. G.K. Vemulapilli, Physical Chemistry, Prentice Hall of India.
7. Gurdeep Raj, Advanced Physical Chemistry, Goel Publishing House, Meerut.
8. S. Glastone& D. Lewis, Elements of Physical Chemistry, The MacMillan Press Ltd., London.
9. P.W. Atkins, Physical Chemistry, Oxford University Press, Oxford, 1998, 6th Edn.
10. G.M. Barrow, Physical Chemistry, McGraw Hill, 1992, 5th Edn.
11. W.J. Moore, Physical Chemistry, Orient Longmans, 4th Ed.
12. N. Kundu& S.K. Jain, Physical Chemistry, Sulthan Chand & Company.
13. P.R. Singh & S.K. Dixit, Molecular Spectroscopy, Sulthan Chand & Company.
14. C.N.R. Rao& J. Gopalakrishnan, New Directions in Solid State Chemistry, Cambridge University Press, 1997.

BBICG613: ANALYTICAL CHEMISTRY

Credits: 4 **Total Hours: 56**

Module I: Statistical treatment of analytical data (14hrs)

Error in chemical analysis - Accuracy, precision, Types of error-absolute and relative error, methods of eliminating or minimizing errors. Methods of expressing precision: mean, median, deviation, average deviation and coefficient of variation. Significant figures and its application with respect to the glassware used. Normal error curve and its importance.

Module II: Separation and purification techniques (14hrs)

Analytical Chemistry – scope, functions, analytical process, Sampling – Collection, preservation and preparation of sample, Techniques of sampling solids, liquids and gases, Operation of drying and preparing a solution of the analyte.

General purification techniques - Purification of solid organic compounds, recrystallization, use of miscible solvents, use of drying agents and their properties, sublimation. Purification of liquids. - Experimental techniques of distillation, fractional distillation, distillation under reduced pressure. Chemical methods of purification and test of purity.

Solvent extraction Efficiency of extraction, Selectivity of extraction, Extraction system, Method of extraction, applications. Soxhlet extraction. Detection and estimation of metallic elements in ores and alloys.

Module III: Titrimetric methods of analysis (14hrs)

General principle. Types of titrations. Requirements for titrimetric analysis. Concentration systems: Molarity, normality, wt%, ppm, and mill moles - problems. Primary and secondary standards, criteria for primary standards, preparation of standard solutions, standardization of solutions. Limitation of volumetric analysis, endpoint and equivalence point.

Acid-base equilibria, pH of strong and weak acid solutions. Buffer solutions. Preparation of acidic and basic buffers. Relative strength of acids and bases from Ka and Kb values. Neutralisation-titration curve, theory of indicators, choice of indicators. Use of phenolphthalein and methyl orange.

Complexometric titrations Stability of complexes, titration involving EDTA. Metal ion indicators and characteristics.

Redox titrations – titration curve –titrations involving MnO_4^- and $Cr_2O_7^{2-}$, redox indicators.

Module IV: Solubility equilibria (14hrs)

General Separation Techniques: Solubility and solubility products, expressions for solubility products. Determination of solubility from solubility products.

Precipitation titrations Argentometric titrations, indicators for precipitation titrations involving silver. Determination of chloride by Volhard's method. Adsorption indicators.

Gravimetric methods of analysis - Precipitation reactions, conditions of precipitation, nucleation, particle size, crystal growth, colloidal state, ageing, impurities in the analytical precipitate, co-precipitation, precipitation from homogenous solution, drying and ignition of precipitation, Applications.

References

1. Elementary Organic Spectroscopy: Principles and Chemical Applications, S. Chand and company Ltd., Ram Nagar, New Delhi, 1990.
2. V. K. Srivastava, K.K. Srivastava, Introduction to Chromatography: Theory and Practice, S. Chand and company, New Delhi, 1987.
3. R.M. Roberts, J.C. Gilbert, L.B. Rodewald, A.S. Wingrove, Modern Experimental Organic Chemistry, 4th edition, Holt Saunders international Editions.
4. A.K. Srivastava, P.C. Jain, Chemical Analysis: An Instrumental Approach for B.Sc. Honours and M.Sc. Classes, S. Chand and company Ltd., Ram Nagar, New Delhi.

BBICG614: CHEMICAL PROCESS ECONOMICS AND ENTREPRENEURSHIP

Credits: 4 **Total Hours: 56**

Unit I: The Entrepreneurial Development Perspective (8 hrs)

Concepts of Entrepreneurship Development, Evolution of the concept of Entrepreneur, Entrepreneur Vs. Intrapreneur, Entrepreneur Vs. Entrepreneurship, Entrepreneur Vs. Manager, Attributes and Characteristics of a successful Entrepreneur, Role of Entrepreneur in Indian economy and developing economies with reference to Self -Employment Development, Entrepreneurial Culture.

Unit II: Creating Entrepreneurial Venture and Project Management (8 hrs)

Business Planning Process, Environmental Analysis -Search and Scanning, Identifying Problems and opportunities, Defining Business Idea, Basic Government Procedures to be complied with, Technical, Financial, Marketing, Personnel and Management Feasibility, Estimating and Financing funds requirement -Schemes offered by various commercial banks and financial institutions like IDBI, ICICI, SIDBI, SFCs, Venture Capital Funding.

Unit III: Entrepreneurship Development and Government (10 hrs)

Role of Central Government and State Government in promoting Entrepreneurship - Introduction to various incentives, subsidies and grants, Fiscal and Tax concessions available, Role of following agencies in the Entrepreneurship Development -District Industries Centers (DIC), Small Industries Service Institute (SISI),Entrepreneurship Development Institute ofIndia (EDII), National Institute of Entrepreneurship & Small Business Development (NIESBUD), National Entrepreneurship Development Board (NEDB), Why do Entrepreneurs fail -The FOUR Entrepreneurial Pitfalls (Peter Drucker), Women Entrepreneurs:Reasons for Low / No Women Entrepreneurs, Role, Problems and Prospects. Case studies of Successful Entrepreneurial Ventures, Failed Entrepreneurial Ventures and Turnaround Ventures.

Unit IV: Management Theories and Managerial Work (10 hrs)

Stages of team development (Tuckman), Team role theory (Belbin), Management roles (Henry Mintzberg), Situational leadership (Blanchard), Hierarchy of needs (Maslow), Five competitive forces (Porter), Interview of mid / large cap industry professional (preferably

MBA) to understand practical usage of any of these theories. Business communication, communication process, communication styles, and communication forms in organizations, fundamentals of business writing, patterns of business messages, report writing, public speaking and oral reporting, verbal and nonverbal communication, use of visual and presentation aides, and cultural and international dimensions of communication, Organization behaviour.

Unit V: Project Management based on Microsoft Project (10 hrs)

Introduction, Project management concepts, Using Microsoft project, Start your plan, Adding resources to the model, Resource management & crashing, Resource rates & using calendars, Handling multiple projects, Uncertain activity times, Tracking, Baseline &reports, 16 Assignment – case study of a project involving various resources, timeline & costs, Business excellence through six sigma and kaizen.

Unit VI: Marketing Management (10 hrs)

Introduction to the basic concepts and principles of marketing, Consumer Behavior, Marketing Research, Product & Brand Management, Integrated Marketing Communications, Marketing Channels, International Marketing, Internet Marketing, Business-to-Business Marketing, Understanding the role of marketing in society and the firm, marketing concept, market segmentation, target marketing, demand estimation, product management, channels of distribution, promotion and pricing.

Reference

1. Entrepreneurship: New Venture Creation -David H. Holt, Prentice Hall PTR, 1992.
2. Entrepreneurship -Robert D. Hisrich, Michael P. Peters, Dean A. Shepherd, McGraw-Hill Education, 2013.
3. The Culture of Entrepreneurship -Brigitte Berger, Ics Press, 1991.
4. Project Management -K. Nagarajan, New Age International, 2004.
5. Dynamics of Entrepreneurship Development -Vasant Desai, Himalaya Publishing House, 2001.
6. Entrepreneurship Development: An Interdisciplinary Approach, S. G. Bhanushali, Himalaya Publishing House, 1987
7. Thought Leaders –Shrinivas Pandit, Tata McGraw-Hill Education, 2002.

8. Entrepreneuring: The Ten Commandments for Building a Growth Company, Steven C. Brandt, Archipelago Pub., 1997.
9. Business Gurus Speak -S.N. Chary, 2002.
10. The Entrepreneurial Connection –Gurmit Narula, Tata Mc- Graw Hill.
11. Business Marketing Management: B2B, Michael Hutt, Thomas Speh, Cengage Learning, 2012

SKILL COMPONENTS

SEMESTER I

JUNIOR RUBBER TECHNICIAN COURSE (NSQF Level - 4)

BBICS101: RUBBER SCIENCE AND TECHNOLOGY – I

Credits: 6 **Total Hours: 84**

BBICS1P01: RUBBER SCIENCE AND TECHNOLOGY - I (Industrial Training and Lab)

Credits: 6 **Total Hours: 168**

Theory and Practical

Sl. No	Module	Theory & Assessment (Hrs)	Practical (Hrs)	Duration (Hrs)	Key Learning Outcomes	Corresponding NOS Code
1	Introduction to rubber sector and manufacturing process	14	42	56	• Explain the importance of rubber sector • Explain basic Concepts- monomers and polymers • Identify Types of polymers-plastics, rubbers, fibres, resins • Explain Natural Rubber and its cultivation • List the properties of NR • Develop the knowledge on Collection, preservation and concentration of latex • Describe the Production of RSS, crepe rubbers and TSR • Choose rubber types for specific applications • Distinguish between types of Synthetic rubbers on	RSC/N 3101

					basis of General Purpose and Special purpose • Compare properties and applications of synthetic rubbers • Explain Reclaimed Rubber, its production, types and application	
2	Rubber Processing Machines	28	28	56	• Identify various machines used for rubber mixing, process the rubber compounds to make articles out of rubber compounds. • Describe the working principles, features, parts and components of machines used for rubber mixing, process the rubber compounds to make articles out of rubber compounds. • Explain new age practices and methods adopted in maintenance.	RSC/N 3102
3	Rubber manufacturing process	28	56	84	• Describe various manufacturing processes • List out the compounding ingredients, Rubber vulcanisation agents and Compounding ingredients other than curatives • Explain the method of quality tests on ingredients • Carry out Compound design and preparation • Explain Latex Compounding and its principles • Carry out Preparation of dispersions and emulsions • Practice testing of Rubbers, rubber compounds & products • Follow standards & specifications of systems and products • Follow safety guidelines.	RSC/N 3103

4	Industrial use of rubber	14	42	56	• List the industrial use of rubber, different product groups. • Explain the techniques involved in manufacturing of rubber products. • Describe application of various material handling equipments in rubber industry.	RSC/N 3101
Total		**84**	**168**	**252**		

Requirements to conduct practical for the course

1. Raw materials and chemicals.
2. General laboratory equipment and glassware.
3. Standard chemicals, reagents and reference materials.
4. Physical testing equipment for rubber and allied materials.
5. Relevant analytical instruments.
6. Computer, calculators and relevant software.
7. Reference books, national/ international standards for raw materials and test methods.
8. Housekeeping and safety equipments

BBICS1IN01: INTERNSHIP FOR JUNIOR RUBBER TECHNICIAN

Credits: 6

Duration of internship	168
Prospective organizations	CFSC and rubber product manufacturing units in Industrial Estate Changanacherry.
Mode of engagement	Full day
Duration of engagement	8 hrs

SEMESTER II

LAB CHEMIST COURSE (NSQF Level - 5)

BBICS202: RUBBER SCIENCE AND TECHNOLOGY – II

Credits: 6 **Total Hours: 84**

BBICS2P02: RUBBER SCIENCE AND TECHNOLOGY – II

TESTING AND ANALYSIS OF RUBBER (Industrial Training and Lab)

Credits: 5 **Total Hours: 140**

Theory and Practical

Sl. No	Module	Theory & Assessment (Hrs)	Practical (Hrs)	Duration (Hrs)	Key Learning Outcomes	Corresponding NOS Code
1	Acquisition of Soft Skills	7	14	21	General computer applications	
2	Learning of organizational working guidelines	7	14	21	System documentation and data recording in a rubber testing lab. Reporting methods, problem identification and escalation.	RSC/ N5002
3	Awareness of Safety, health and environment aspects	14	28	42	Knowledge about safety, health and environment in a laboratory; health hazards in handling chemicals; safe disposal of waste in rubber lab; safety aspects of handling lab equipment etc.	
4	Introduction to Rubber Technology	14	28	42	Introduction to rubbers, compounding ingredients including textile materials; Unit operations in rubber processing and product manufacturing industries; RSS,	

					TSR, Cenex. Introduction to analytical chemistry; Basic objectives of analysis and testing; definition of quality of materials, national, international company quality standards, specifications and test methods. General lab equipment. Instrumental analysis; colorimetry, spectrophotometry, IR/UV, NMR, Electron microscopy etc. Use of statistical methods in analysis and testing. Methods of compilation of analytical data and reporting.	
5.	Acquisition of NOS specific process awareness - Lab Chemist	42	56	98	Housekeeping in laboratory, methods of cleaning of labware, general organization of lab., Sample collection and preparation, Preparation of standard reagents and reference materials to be used in the testing process, Specifications and test methods for raw materials, Analysis of test data and presentation of the same, Specific safety aspects related to laboratory testing, Specific documentation aspects related to laboratory testing	RSC/ N5001 RSC/ N1201 RSC/ N5003 RSC/ N5004
	Total	**84**	**140**	**224**		

Requirements to conduct practical for the course

1. Raw materials and chemicals.
2. General laboratory equipment and glassware.
3. Standard chemicals, reagents and reference materials.
4. Physical testing equipment for rubber and allied materials.
5. Relevant analytical instruments.
6. Computer, calculators and relevant software's.
7. Reference books, national/ international standards for raw materials and test methods.
8. Housekeeping and safety equipments.

BBICS2IN02: INTERNSHIP FOR LAB CHEMIST

Credits: 7

Duration of internship	196
Prospective organizations	CFSC and rubber product manufacturing units in Industrial Estate Changanacherry.
Mode of engagement	Full day
Duration of engagement	8 hrs

SEMESTER III

BBICS303: POLYMER CHEMISTRY

Credits: 5 **Total Hours: 70**

Module I: Introduction to polymers (20 hrs)

Importance of polymers: Basic concept- monomers and polymers - definition. Classification of polymers on the basis of microstructures, macrostructures and applications. Distinction among plastics, elastomers and fibres. Homo and heteropolymers. Copolymers. Chemistry of polymerization, Chain polymerisation, Free radical, ionic, coordination, step Polymerisation, Polyaddition and polycondensation, miscellaneous ring-opening and group transfer polymerisations.

Module II: Physical properties and reactions of polymers (20 hrs)

Properties: Glass transition temperature (Tg)- Definition- Factors affecting Tg-relationship between Tg and molecular weight and melting point. Importance of Tg Molecular weight of polymers: Number average, weight average, sedimentation and viscosity average molecular weights. Molecular weights and degree of polymerisation. Determination of polymer molecular weight Reactions: hydrolysis-hydrogenation– addition - substitutions-cross-linking vulcanisation and cyclisation reactions. Polymer degradation. Basic idea of thermal, photo and oxidative degradations of polymers.

Module III: Polymerisation techniques and processing (10 hrs)

Polymerisation techniques: Bulk, solution, suspension, emulsion, melt condensation and interfacial polycondensation polymerisations. Polymer processing: Calendaring - die casting, rotational casting - compression. Injection moulding.

Module IV: Chemistry of commercial polymers (20 hrs)

General methods of preparation, properties and uses of the following Polymers: Teflon, polymethyl methacrylate, polyethylene, polystyrene, PAN, polyesters, polycarbonates, polyamides, (Kevlar), polyurethanes, PVC, epoxy resins, rubber-styrene and neoprene rubbers, Phenol - formaldehydes and urea-formaldehyde resins.

References

1. Billmeyer F.W., Textbook of polymer science, Jr.John Wiley and Sons, 1994.
2. Gowariker V.R., Viswanathan N.V. and JayaderSreedhar, Polymer Science, Wiley Eastern Ltd., New Delhi.
3. Sharma, B.K., Polymer Chemistry, Goel Publishing House, Meerut, 1989.
4. Arora M.G., Singh M. and Yadav M.S., Polymer Chemistry, 2nd Revised edition, Anmol Publications Private Ltd., New Delhi, 1989.

BBICS3P03: POLYMER CHEMISTRY LAB

Credits: 4 **Total Hours: 112**

Any six preparation of the following (preparations are only illustrative, same or similar may be carried out)

1. Preparation of nylon -6,6 (Interfacial polycondensation)
2. Preparation of PMMA (free radical bulk polymerisation)
3. Preparation of polyacrylamide (free radical polymerisation)
4. Preparation of polyacrylamide (redox polymerisation)
5. Preparation of glyptal resin
6. Preparation of linear polystyrene (free radical polymerisation)
7. Preparation of crosslinked polystyrene (suspension polymerisation)
8. Preparation of phenol formaldehyde resin (resoles and novolaks)
9. Preparation of urea formaldehyde resin
10. Preparation of polyaniline
11. Preparation of aniline formaldehyde resin

Viscometry– determination of molecular weight of polymers by dilute solution viscometry of polymers.

Polymer Characterisation

Systematic identification of virgin and compounded polymer sample:

Rubbers-NR, SBR, NBR, butyl rubber, neoprene, PB, polychloroprene

Plastics-PE, PP, PVC, nylon6, nylon 66, PVAl, PS, PMMA, ABS

SEMESTER III & IV

QUALITY ASSURANCE SUPERVISOR (NSQF Level - 6)

BBICS404: RUBBER SCIENCE AND TECHNOLOGY – III

Credits: 11 **Total Hours: 154**

BBICS4P04: QUALITY ASSURANCE SUPERVISOR (Industrial Training and Lab)

Credits: 9 **Total Hours: 252**

Theory and Practical

Sl. No	Module	Theory & Assessment (Hrs)	Practical (Hrs)	Duration (Hrs)	Key Learning Outcomes	Corresponding NOS Code
1	Acquisition of Soft Skills	14	28	42	General computer applications skills	
2	Learning of organizational working guidelines	28	28	56	System documentation and data recording in a rubber processing factory, organizational structure and heigherarchy; problem identification and escalation, reporting methods	RSC/ N5002
3	Awareness of safety, health and environment aspects related to rubber processing	28	28	56	Knowledge about safe handling of rubber processing equipment, electrical and utility installations, firefighting equipment and methods, safe handling of chemicals and materials, MSDS, use. of personal protective equipment etc.	
4.	Introduction to rubber processing	28	42	70	Introduction to marketable forms of NR, RSS, TSR, Cenex, organization of rubber processing factory, raw	

					materials for production of different marketable forms of NR, storage and handling of raw materials, selection of right raw material for production of different grades of products, preprocessing operations, unit operations in rubber processing, Engineering terms familiarization, Material handling equipment, storage of finished products.	
5	Acquisition of NOS specific process awareness - Quality Assurance Supervisor	56	126	182	Quality standards for processed forms of NR both national and international, Need to maintain quality, customer requirements and guidelines, influence of various factors affecting the quality of finished products, control of process variables to achieve the desired quality, methods of drawing samples of raw materials and finished products, test methods for TSR, RSS, Cenex, organization of quality control lab, data collection and analysis, adjustments in process variables to improve the desired quality, laison with customers and standards organizations, packing of finished products as per standard and customer requirements, marking of quality, safe storage of finished products; Modern quality control methods as applicable to processed NR, statistical process and quality control, interpretation of lab testing data etc.	RSC/ N5001 RSC/ N1201 RSC/ N5003 RSC/ N5004
	Total	**154**	**252**	**406**		

Requirements to conduct practical for the course

1. Raw materials and chemicals.
2. General laboratory equipment and glassware.
3. Standard chemicals, reagents and reference materials.
4. Physical testing equipment for rubber and allied materials.

5. Relevant analytical instruments.
6. Computer, calculators and relevant software’s.
7. Reference books, national/ international standards for raw materials and test methods.
8. Housekeeping and safety equipments.

BBICS4IN03: INTERNSHIP FOR QUALITY ASSURANCE SUPERVISOR

Credits: 7

Duration of internship	196 hours
Prospective organizations	CFSC and rubber product manufacturing units in Industrial Estate Changanassery.
Mode of engagement	Full day
Duration of engagement	8 hrs

SEMESTER V

BBICS505: MODERN ANALYTICAL INSTRUMENTATION

Credits: 5 **Total Hours: 70**

Module I: Chromatography (30 hrs)

Principle of adsorption and partition chromatography. Column chromatography - adsorbents, classification of adsorbents, solvents, different types of chromatography, preparation of column, adsorption and applications. Thin Layer Chromatography - choice of adsorbent, choice of solvent, preparation of chromatogram, sample, R_f value and its applications. Paper chromatography, solvent used, R_f value, factors which affect R_f value. Ion exchange chromatography, resins used, experimental techniques, applications.

Module II: Capillary electrophoresis and capillary electro chromatography (20 hrs)

Capillary electrophoresis-migration rates and plate heights, instrumentation, sample introduction, detection methods, applications. Capillary gel electrophoresis. Capillary isotachophoresis. Isoelectric focusing.

Capillary electro chromatography-packed columns. Micellar electro kinetic chromatography.

Module III: Thermal and radiochemical methods (20 hrs)

Thermogravimetry (TG), Differential Thermal Analysis (DTA) and Differential Scanning Calorimetry (DSC) and their instrumentation. Thermometric Titrations.

Measurement of alpha, beta, and gamma radiations, neutron activation analysis and its applications. Principle and applications of isotope dilution methods.

References

1. J.M. Mermet, M. Otto, R. Kellner, Analytical Chemistry, Wiley-VCH, 2004.
2. D.A. Skoog, D.M. West, F.J. Holler, S.R. Crouch, Fundamentals of Analytical Chemistry, 8th Edn., Saunders College Pub., 2007.
3. J.G. Dick, Analytical Chemistry, R.E. Krieger Pub.1978.
4. J.H. Kennedy, Analytical Chemistry: Principles, Saunders College Pub., 1990.
5. G.H. Jeffery, J. Bassett, J. Mendham, R.C. Denney, Vogel's Text Book of Quantitative Chemical Analysis, 5th Edn., John Wiley & sons,1989.

6. S.E. Manahan, Environmental Chemistry, 9th Edn., CRC Press, 2010.
7. C.L. Wilson, D.W. Wilson, Comprehensive Analytical Chemistry, Elsevier, 1982.
8. G.D. Christian, J.E. O'Reilly, Instrumental Analysis, Allyn & Bacon, 1986.
9. R.A. Day, A.L. Underwood, Quantitative Analysis, Prentice Hall, 1967.
10. A.I. Vogel, A Textbook of Practical Organic Chemistry, Longman, 1974.
11. H.A. Laitinen, W.E. Harris, Chemical Analysis, McGraw Hill, 1975.
12. V.K. Ahluwalia, Green Chemistry: Environmentally Benign Reactions, CRC, 2008.
13. F.W. Fifield, D. Kealey, Principles and Practice of Analytical Chemistry, Blackwell Science, 2000.
14. W. Horwitz (Editor), Official Method of Analysis of AOAC International, 18th Edn., AOAC, 2010
15. British Pharmacopeia, TSO, 2012.

BBICS5P05: ENVIRONMENTAL CHEMISTRY LAB

Credits: 4 **Total Hours: 112**

Water analysis

1. Determination of pH
2. Determination of acidity and alkalinity
3. Determination of conductivity
4. Determination of DO
5. Determination of total solids (Gravimetry)
6. Determination of total dissolved solids (Gravimetry)
7. Determination of total suspended solids (Gravimetry)
8. Determination of chlorides
9. Estimation of carbon dioxide
10. Estimation of iron (Colorimetric)
11. Estimation of residual chlorine
12. Hardness
13. Chemical oxygen demand (COD)
14. Biochemical oxygen demand (BOD)
15. Estimation of fluoride
16. Estimation of phosphate
17. Estimation of Nitrate
18. Estimation of Nitrite
19. Estimation of Total Nitrogen (Kjeldahl method)(Demonstration)
20. Estimation of Sodium & Potassium (Flame photometry)(Demonstration)
21. Detection of pesticides using TLC / paper chromatography
22. Analysis of heavy metals – As, Hg, Pb, Cd(Demonstration)
23. Estimation of sulphate

SEMESTER V & VI

RUBBER TECHNOLOGIST (NSQF Level - 7)

BBICS606: RUBBER TECHNOLOGY AND MANUFACTURE

Credits: 11 **Total Hours: 154**

BBICS6P06: RUBBER TECHNOLOGY AND MANUFACTURE (Industrial Training and Lab)

Credits: 9 **Total Hours: 252**

Theory and Practical

Sl. No	Module	Theory & Assessment (Hrs)	Practical (Hrs)	Duration (Hrs)	Key Learning Outcomes	Corresponding NOS Code
1	Acquisition of soft skills	14	28	42	General computer applications	
2	Learning of organizational working guidelines	28	28	56	Organization of a rubber processing and product manufacturing company. Development of basic systems and methods.	RSC/ N5002
3	Awareness of safety, health and environment aspects related to rubber processing and product manufacturing	28	42	70	Safety health and environment aspects related to rubber processing and product manufacturing equipment. Various methods of preventing environmental pollution. Health hazards of handling various chemicals and other raw materials in the rubber industry, MSDS,; Personal protective equipment in the rubber industry; Occupational health hazards in rubber industry	

4	Introduction to rubber technology and manufacture	28	42	70	Raw materials for rubber product manufacture; NR and various synthetic rubbers, rubber/plastic blends, compounding ingredients, textile materials; Engineering terms familiarization, Material handling equipment; principles of rubber compounding; Unit operations, mixing, extrusion, calendering, moulding; Introduction to industrial uses of rubber, tyres and tubes, non-tyre products; latex technology _ preservation and concentration of NR latex, synthetic latices, latex compounding, manufacture of latex products	
5	Acquisition of NOS specific process awareness - Rubber Technologist	56	112	168	Preparation of factory layout for rubber product manufacture, selection of various machineryand it's installation; design of the rubber compound and organization of production, quality control tests for the products, process optimization; Finishing operations, packing; Liaison with customers and modifications of the process to take care of customer requirements; Identification of problems and escalation.	RSC/ N5001 RSC/ N1201 RSC/ N5003 RSC/ N5004
	Total	**154**	**252**	**406**		

Requirements to conduct practical for the course

1. Raw materials and chemicals.
2. Lab model rubber mixing mill, extruder, calendaring, moulding press, moulds
3. Testing equipment like hardness tester, specific gravity meter etc.
4. Physical testing equipment for rubber and allied materials
5. Computer, calculators and relevant software
6. Essential tools for the processes
7. Housekeeping and safety equipment

BBICS6IN04: INTERNSHIP FOR RUBBER TECHNOLOGIST

Credits: 5

Duration of internship	140 hours
Prospective organizations	RTI, Rubber Board, CFSC Changanacherry and rubber processing and manufacturing units in and around Kottayam district.
Mode of engagement	Full day
Duration of engagement	8 hrs

References

1. Billmeyer Textbook of Polymer Science
2. Blackley, D.C, High polymer latices: Their science and technology Vol 1, Maclaren and Sons Ltd., London 1966
3. Blackley, D. C Polymer Latices : Science and technology Vol 2, Chapman and Hall Madras,1997
4. Blow, C.M, .Rubber Technology and Manufacture
5. Sethuraj M.R and Mathew, N.M, Natural Rubber : Biology Cultivation and Technology, Elsevier, Amsterdam 1992
6. Roberts, A.D, Natural Rubber Science and Technology, Oxford University Press, Oxford, 1988

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