

**Study Guide/Curriculum
Science of Dental Materials
Second Year BDS**



**CMH Lahore Medical College
&
Institute of Dentistry**

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Vision Statement

The CMH Lahore Medical College and Institute of Dentistry aims to provide a highly conducive environment to train a new generation of technology savvy and socially responsible healthcare providers who are well-versed with their role within a healthcare team and while serving the community, demonstrate abilities to practice requisite communication skills, empathy, lifelong learning, critical thinking and decision making at a national or an international facility.

Mission Statement

The mission of CMH Lahore Medical College and Institute of Dentistry is to undertake following steps to materialize their vision:

1. Ensure provision of a conducive educational environment where students feel well-supported through implementation of learner-centered teaching approaches, inbuilt strong feedback loops and physically comfortable learning environment.
2. Sensitization of students about their role in the society as socially responsible professionals through participation in extracurricular activities like community-based programs, patient welfare societies, blood donors' society, and productive contribution to combat local and national calamities.
3. Students' exposure to the healthcare community, where sympathy and empathy are the cornerstones of our practice. Students commit to understanding their patients not only through their medical conditions but also through their emotions, fears, and unique life experiences. By fostering a culture of compassion, students aim to provide not just medical care but genuine understanding and support to enhance the well-being of those we serve.
4. Students' exposure to cutting-edge technology through campus learning management system and development of their e-portfolios.
5. Leadership and Smart Learning Strategies through implementation of interprofessional curriculum for undergraduate health professions' education students enrolled in medical, dental, allied health sciences, and nursing programs.
6. Provision of opportunities to undergraduate and post-graduate students to have practical experience of leading, working as a team member, critical thinking, problem solving, and decision making.
7. Formal teaching and training of professionalism for students to develop their full potential including communication, and lifelong learning skills through portfolio development among undergraduate and postgraduate students.
8. Implementation of a task-based and outcome oriented longitudinal module on 'Research' for undergraduate students, leading to publication of research article/s and for cultivation of evidence-based practices.

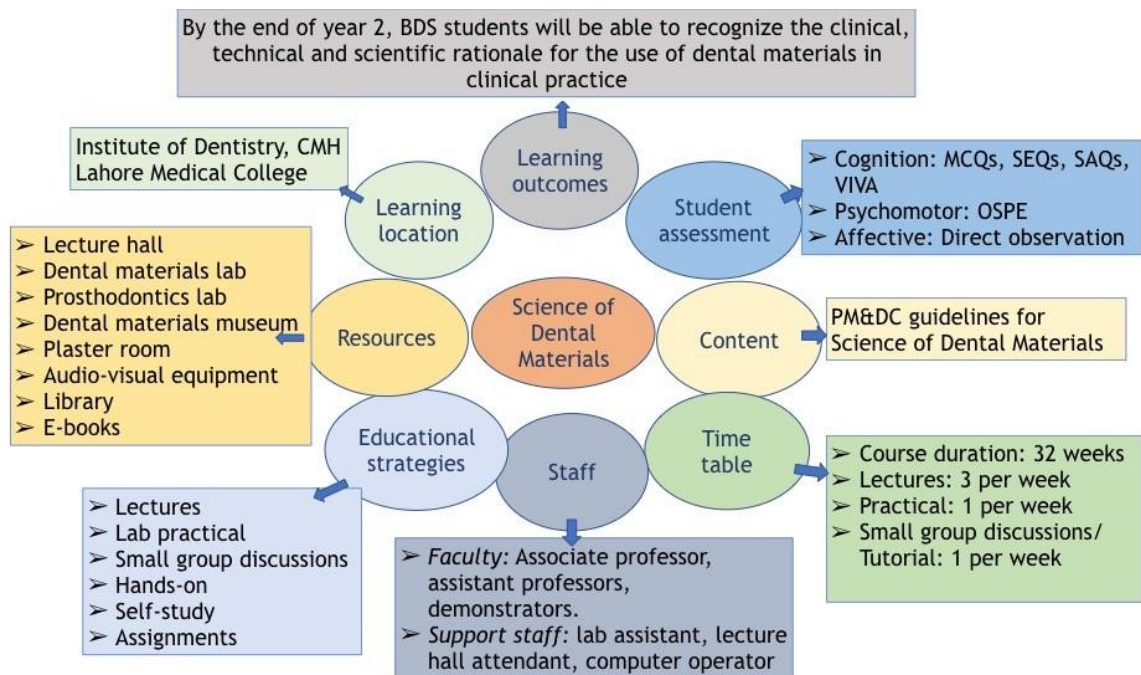
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INTRODUCTION TO SCIENCE OF DENTAL MATERIALS

The subject of science of dental materials at undergraduate level enables the students to recognise the clinical, technical, and scientific rationale for the use of materials in clinical dental practice. The course curriculum is designed to introduce dental materials science to students and facilitate their study of physical and chemical properties that are related to selection of these products by the dentist and to identify characteristics of materials that affect their biological safety. The practical component of the course involves hands-on experience of the materials and their manipulation in the laboratory. The subject of science of dental materials covers the following main sections:

Curricular Map Science of Dental Materials



RESOURCES

- A. Teaching resources
- B. Infrastructure resources

A. Teaching resources

i. Faculty members

Sr. #.	Faculty Name	Department as per PM & DC certificate	Qualification
1	Dr. Salman Aziz	Associate Professor	BDS, MSc, PhD
2	Dr. Usman Ashraf	Assistant Professor	BDS, MSc, PhD
3	Dr. Hafiz M. Owais Nasim	Assistant Professor	BDS, M.Phil
3	Dr. Nain Zahra Najfi	Demonstrator	BDS
4	Dr. Rija Asghar	Demonstrator	BDS
5	Dr. Wajeeha Lodhi	Demonstrator	BDS

ii. Supporting staff:

- Lab assistant
- Computer operator/lecture hall attendants

B. Infrastructure resources

Sr. #.	Infrastructure Resources	Quantity
1	Lecture hall <ul style="list-style-type: none">• Seating Capacity• Multimedia• Microphone• Computer system	1
2	Science of Dental Materials <ul style="list-style-type: none">• Dental materials lab• Prosthodontics lab• Plaster room• Dental materials museum• Skills Lab	1
3	Mini library/ e-library	1

TEACHING AND LEARNING STRATEGIES

Multiple educational methods will be used comprising of self-study, interactive lectures, group discussions, practical, and manual dexterity skill sessions.

(i) Methods for achieving cognitive objectives.

- Interactive lectures using audio visual aids on power point presentation.
- Group discussions in form of large group and small group
- Collaborative learning
- Self-study and reading from learning resources.

(ii) Methods for achieving psychomotor objectives.

- Practicing correct handling, dispensing and manipulation of different dental materials during hands on laboratory practicals.

(iii) Methods for achieving affective objectives.

- Interaction with peers, group members, teachers, support staff etc.
- Group discussions (small and large)
- Oral presentations by students

LEARNING METHODOLOGIES

The following teaching /learning methods are used to promote better understanding:

- Interactive lectures
- Small group discussions
- Practical
- Self-directed learning
- Assignments
- Oral presentations by students

Interactive lectures

In large group, the lecturer introduces a topic which explains the underlying phenomena through questions, pictures, exercise, etc. Students are actively involved in the learning process.

Small group discussions

This format helps students to clarify concepts and acquire skills and attitudes. Students exchange opinions and apply knowledge gained from lectures and self-study. The facilitator role is to ask probing questions, summarize, or rephrase to help clarify concepts.

Practical

It involves hands on experience with the materials so that students can understand issues related to dispensing, handling, manipulation, and practical application of dental materials. They are also required to maintain practical manuals in which they draw and label histological diagrams and different aspects/ views of teeth for better understanding.

Self- directed learning

Students' take responsibilities of their own learning through individual study, sharing and discussing with peers, seeking information from Learning Resource Centre, teachers, and resource persons within and outside the college. Students can utilize the time within the college hours or afterwards for self-study.

Assignments

Students are given written formative assignments on designated topics. For revision purpose, the topics already covered are given to students as oral presentations.

Oral presentations by students

Students are assigned topics during revision session to enhance their communication skills and group learning.

CURRICULUM IMPLEMENTATION

Curriculum implementation refers to putting into practice the official document including course content, objectives, learning and teaching strategies. Implementation process helps the learner to achieve knowledge, skills and attitudes required of the learning tasks. Learners are a pertinent component of the implementation process. Implementation occurs when the learner achieves the intended learning experiences, knowledge, ideas, skills, and attitudes, which are aimed to make the learner an effective part of the society. Curriculum implementation also refers to the stage at which curriculum is put into effect. There must be an implementing agent as well. Teacher is an important part of this process and implementation of the curriculum is the way the teacher selects and utilizes various components of the curriculum. Implementation occurs when the teacher's formulated course content, teacher's personality and teaching and learning environment interact with the learners. Therefore, curriculum implementation is how the officially planned course of study is translated and reflected by the teacher into schemes of work, lesson plans, syllabus and resources are effectively transferred to the learners. Curriculum implementation can be affected by certain factors such as teachers, learners, learning environment, resource materials and facilities, culture and ideology, instructional supervision, and assessments.

Personnel involved in teaching and facilitation.

- **Lectures delivery by:** Dr. Salman Aziz (Associate Professor/Subject Incharge)
Dr. Usman Ashraf (Assistant Professor)
Dr. Owais Nasim (Assistant Professor)
- **Demonstrators for practical and small group discussion sessions:**
Dr. Rija Asghar, Dr. Nain Zahra, Dr. Wajeeha Lodhi
- **Support staff: 2**
As nominated by the medical education department.
- **Computer assistant: 1**
As nominated by the college.

Time frame

Course duration: 39 weeks

Lectures:

Tuesday (8:00 am to 8:50 am)

Thursday (12:40 pm to 1:30 pm)

Friday (8:50 am to 9:40 am)

Practical/Small Group Discussion: Friday (10:30 am to 12:40 pm)

Self-Directed Learning: Tuesday (3:00 - 4:00 pm)

Study hours lectures = 97.5 hours

Study hours practicals/Small Group Discussion = 84.5 hours

Total study hours = 221 hours

COURSE OUTLINE

SECTION I General classes and properties of dental materials

This section introduces students to the general classification and brief overview of different types of preventive and restorative materials used in dentistry. It illustrates the terms and principles involved in describing the clinical behaviour of these materials based on their physical, chemical, and mechanical properties. It also highlights the knowledge of appreciation of certain biological considerations for use of dental materials in oral cavity and hazards associated with them. The section aims to provide basic background knowledge regarding structure of matter and to provide a comprehensive account of relationship between general properties of dental materials and their clinical performance. Another aspect of importance is the potential of this information to predict clinical performance under biological limitations and to allow the students to develop a critical understanding of the factors that determine the safe and correct use of materials in dentistry.

SECTION II Direct restorative materials

This section familiarizes students with a number of key themes and subjects regarding different types of direct restorative materials used in dentistry. It is designed to provide detailed information regarding historical background, types, properties, biological consideration, clinical applications, limitations, and selection criteria of direct restorative materials. The aim of this section is to allow students to develop scientific knowledge, understanding and competence in direct restorative materials. Based on the information regarding their clinical behaviour and selection criteria students will be able to grasp the scientific rationale for use of these materials for their clinical applications.

SECTION III Indirect restorative materials

The section covers detailed information regarding the physical, chemical, and biological properties, manipulation and handling characteristics of indirect restorative materials used in dentistry. This includes detailed study of scientific and clinical properties of materials such as dental acrylic resins, dental ceramics and metals used in restorative dentistry. The aim of this section is to allow students to develop scientific knowledge, understanding and competence in direct restorative materials. Based on the information regarding their clinical behavior and selection criteria students will be able to grasp the scientific rationale for use of these materials for their clinical applications.

SECTION IV Auxiliary dental materials

The section provides information regarding variety of auxiliary dental materials used in dentistry. Auxiliary dental materials include a range of materials that are involved in the fabrication of different dental prosthesis but that do not become part of the prosthesis. The section aims to develop

knowledge regarding basic features of auxiliary dental materials used in clinical and laboratory procedures. It involves the study of composition, properties, manipulation of auxiliary dental materials and the manner in which they interact with the environment in which they are applied.

SECTION V Preventive dental materials

The section deals with the introduction and knowledge of various preventive materials used in dentistry. It describes different types of preventive dental materials associated with mechanical tooth cleaning, plaque control, fluorides, and fissure sealants. The section aims to introduce students to basic preventive dental materials used in clinical dentistry. It involves the study of composition, properties, manipulation of preventive dental materials and the criteria for proper selection for their clinical application.

SECTION VI Endodontic materials

The section focuses on the material used in endodontics that are used to irrigate and disinfect, obturate and seal the root canal system during endodontic treatment. The section introduces students to different types of endodontic materials classified according to their intended clinical uses. It involves the study of composition, properties, and mode of application of various disinfectants, lubricants, sealants and obturating materials used in endodontics.

SECTION VI Laboratory practicals

The practical component covers the manipulative and applied aspects of dental material science. The laboratory practical component serves to familiarise students with the range of materials used in dentistry. It involves hands on experience with the materials so that students can understand issues related to dispensing, handling, manipulation, and practical application of dental materials.

Teaching & Learning Objectives

Department of Science of Dental Materials

BLOCK 1

Sr No	Topic	• Learning Outcomes	Total Time Assigned	Total Number of Lectures	Instructor	Method of teaching
1	Introductions to Dental Materials + Biocompatibility of Dental Materials	<ul style="list-style-type: none"> • Understand the chemistry of dental biomaterials used in clinical and community setups. • Handling and manipulation of various dental materials. • Demonstrate knowledge of chemical and biological interactions of dental biomaterials. • Understand the safety and biocompatibility of dental biomaterials. • Better understanding of dental biomaterials to deliver optimal clinical services for community. 	4hr 10 min	5	Dr Salman Aziz	LGT/SGD
2	Properties of Dental Materials	<ul style="list-style-type: none"> • Demonstrate knowledge of the fundamental biological, chemical and physical principles that make the foundation of the clinical behavior and application of dental materials. • Describe the structure of matter and explain the principles of adhesion among dental materials • Understand basic classification of dental materials i.e. metals, ceramics, polymers and composites. • Understand the principles involving surface interaction of dental materials in biological environment. • Demonstrate knowledge of the range of biological consideration regarding the 	8 hrs 20 min	10	Dr Usman Ashraf	LGT/SGD

		<p>selection and performance of dental materials for clinical applications.</p> <ul style="list-style-type: none"> • Understand the knowledge of safety, biocompatibility and biomechanics as they relate to the correct clinical use of dental materials. 				
3	Gypsum Products	<ul style="list-style-type: none"> • Understand the properties, types, uses, and manipulation of gypsum products • Understand the method of manufacturing and properties of gypsum products used in dentistry. • Understand the setting reactions of different types of dental gypsum products • Understand the manipulation factors that affect the setting time and physical and mechanical properties of gypsum products. • Discuss the types, method of manufacturing and properties of dental Gypsum products according to the ISO standards. • Understand and demonstrate the methods used for the disinfection of dental gypsum models and study casts. • Understand and demonstrate the proper mixing technique of dental gypsum used for preparing study models and casts. 	3 hrs 20 min	4	Dr Salman Aziz	LGT/SGD/Prac
4	Impression Materials	<ul style="list-style-type: none"> • Enlist the properties, composition and uses of impression materials used in dentistry • Understand the significance of impression and impression materials in dentistry. • Understand the general requirements for an ideal impression material • Explain the techniques used for the disinfection of each type of impression material • Understand the classification, characteristics and properties of elastic and non-elastic impression materials. • Compare the properties and clinical application of 	5 hrs	6	Dr Salman Aziz	LGT/SGD/Prac

		<p>different types of impression materials.</p> <ul style="list-style-type: none"> • Understand and demonstrate proper technique for mixing, handling and manipulation of the elastic and non-elastic impression materials. 				
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BLOCK II

Sr No	Topics	• Learning Outcomes	Total Time Assigned	Total No of Lectures	Name of Instructor	Method of teaching
5	Polymers+ Denture base materials	<ul style="list-style-type: none"> • Understand the definition of denture base materials. • Enlist denture base materials according to the ISO classification and explain their respective properties. • Understand the ideal properties and types of denture base materials. • Understand the chemical composition and properties of denture base materials. • Describe various biocompatibility issues associated with denture base materials. • Understand the various procedures involved in the fabrication of denture base materials. • Understand and discuss clinical application, manipulation, processing, and care of • Dentures for laboratory processed prosthetic resins. • Understand -and describe biocompatibility issues associated with denture base materials. • Describe various methods of polymerization of denture base materials. 	5 hrs	8	Dr Salman Aziz	LGT/SGD/Prac
6	Dental Amalgam	<ul style="list-style-type: none"> • Describe the history, composition and classification of dental amalgams. • Understand the setting mechanism of different types of dental amalgams. 	2 hrs 30 min	3	Dr Owais Nasim	LGT/SGD/Prac

		<ul style="list-style-type: none"> • Understand and explain the properties of dental amalgams. • Understand and demonstrate clinical manipulation and factors affecting the properties of dental amalgams. • Understand the issues related to amalgam hygiene in clinical practice. • Explain the biocompatibility issues relating to dental amalgams • Identify recent advancements in dental amalgams 				
7	Dental Cements + Liners & Bases	<ul style="list-style-type: none"> • Understand the objectives and basic terminologies related to dental cements. • Understand the general requirements, types and properties of different dental cements. • Understand and explain the setting mechanism of different dental cements. • Understand and explain the properties, advantages and disadvantages of different dental cements. • Understand and describe the clinical applications of different dental cements. • Understand the concept of bases and liners for different clinical applications. • Describe luting agents, types and their properties • Understand the use of temporary restorative materials, properties and their uses. • Demonstrate techniques for handling and manipulation of various dental cements. • Describe history, introduction and classification • Explain chemistry and setting reactions • Describe mechanism of adhesion to tooth structure and role of water • Enlist clinical manipulation steps of GICs • Describe Fluoride release and biocompatibility of GICs • Define Atraumatic Restorative Technique (ART) and its uses 	5 hrs 50 min	7	Dr Salman Aziz	LGT/SGD/Prac

		<ul style="list-style-type: none"> Define and explain the sandwich technique and its utility. 				
8	Dental Composites + Adhesive Dentistry	<ul style="list-style-type: none"> Describe the history and classification of restorative composites. Understand and describe the properties of different components of restorative composites. Understand the characteristics and clinical applications for composite restorative materials. Understand and explain different modifications in relation to restorative composites. Understand finishing and polishing procedures for restorative composites. Understand the biocompatibility issue related to restorative composites. Understand the recent advancements in restorative composites. Demonstrate clinical manipulation of restorative composites Indications and usefulness of the sandwich technique Understand the concept of bonding and adhesion in dentistry. Define enamel and dentine bonding. Understand the significance and rationale behind enamel and dentine bonding Understand various types and generations of bonding agents. Understand the significance of biodegradation of restorative resins. Understand and explore recent advancements in dentin bonding agents 	10 hrs	12	Dr Salman Aziz	LGT/SGD/Prac
9	Metal & Alloys + Implant Materials	<ul style="list-style-type: none"> Understands the basic chemistry of metals used in dentistry Demonstrate the knowledge of biocompatibility of metal alloys in dental prosthesis. Understand the concept of bio-integration and use of implant prosthesis. 	7 hrs 30 min	9	Dr Owais Nasim	LGT/SGD/Prac

		<ul style="list-style-type: none"> Understand the basic concept of surface treatment of implant fixtures 				
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BLOCK III

Sr No	Topics	Learning Out Comes	Total Time Assigned	Total No Of Lectures	Name of Instructor	Method of teaching
10	Investment Materials+ Casting + Soldering & Welding	<ul style="list-style-type: none"> Define and explain investment materials used in dentistry. Understand different types of investment materials used in dentistry. Understand the composition, setting reaction and properties of gypsum bond investment. Understand the composition, setting reaction and properties of phosphate bonded investment. Understand the composition, setting reaction and properties of Silica bonded investment. Understand and compare properties and clinical applications of different types of investments. Understand the steps and methods involved in casting procedures. 	5 hrs 50 min	8	Dr Owais Nasim	LGT/SGD
11	Ceramics + CAD/CAM	<ul style="list-style-type: none"> Understand the basic chemistry and composition of ceramics. Understand the composition and classification of different dental ceramics systems. Understand general procedures involved in fabrication of dental ceramics. Understand the concept of metal ceramic bonding. Understand metal ceramic restorations, their uses and properties. Understand all ceramic restoration, their uses and properties. Describe methods of strengthening ceramics. 	5 hrs	6	Dr Usman Ashraf	LGT/SGD
12	Finishing & Polishing Materials	<ul style="list-style-type: none"> Understand the objectives for finishing and polishing of dental restorations and prosthesis. Understand the classification, composition, properties of abrasives and clinical 	1 hr 40 min	2	Dr Salman Aziz	LGT/SGD

		<p>applications for finishing and polishing materials.</p> <ul style="list-style-type: none"> • Understand the principles of finishing and polishing of dental materials. • Understand different types of cutting and abrasive instruments. • Describe biological hazards associated with dental abrasive and polishing materials. 				
13	Tissue conditioners & Separating Media	<ul style="list-style-type: none"> • Understand the ideal properties and types of denture base materials. • Understand -and describe biocompatibility issues associated with denture base materials. • Describe various methods of polymerization of denture base materials. 	1 hr 40 min	2	Dr Usman Ashraf	LGT/Prac
14	Dental Waxes	<ul style="list-style-type: none"> • Understand the classification and types of waxes used in dentistry. • Discuss the composition, properties and application of different types of dental waxes. • Understand and demonstrate manipulation of different types of dental waxes. • Demonstrate setup of teeth in wax pattern developed on articulated upper and lower gypsum casts. 	2 hrs 30 min	3	Dr Usman Ashraf	LGT/SGD/Prac
15	Dental Pharmacology	<ul style="list-style-type: none"> • Understand the scientific aspects of drug prescriptions in dentistry • Understand the knowledge of pharmacokinetics and pharmacodynamics • Understand the importance of patient safety during drug prescription and administration • Understand the actual and potential effects of commonly used medications in dentistry 	2 hrs 30 min	3	Dr Salman Aziz	LGT/SGD
16	Dental Pharmacology		2 hrs 30 min	3	Dr Usman Ashraf	LGT/SGD
17	Smart Materials + Tissue Engineering	<ul style="list-style-type: none"> • Demonstrate the knowledge of tissue sampling techniques • Understand the importance and uses of tissue engineering in dental biomaterials. 	3 hrs 10 min	4	Dr Salman Aziz	LGT/SGD

		<ul style="list-style-type: none"> Understand and demonstrate the knowledge of gene transfer and gene expression 				
18	Emerging trends in Dental Biomaterials	<ul style="list-style-type: none"> Understand the latest developments in materials sciences. Understand the new era of nano-technology. 	1 hr 40 mins	2	Dr Salman Aziz	LGT/SGD

LEARNING OUTCOMES

INTRODUCTION

The subject of science of dental materials at undergraduate level enables the students to recognize the clinical, technical, and scientific rationale for the use of materials in clinical dental practice. The course curriculum is designed to introduce dental materials science to students and facilitate their study of physical and chemical properties that are related to selection of these products by the dentist and to identify characteristics of materials that affect their biological safety. The practical component of the course involves hands-on experience of the materials and their manipulation in the laboratory.

SECTION I GENERAL CLASSES AND PROPERTIES OF DENTAL MATERIALS

This section introduces students to the general classification and brief overview of different types of preventive and restorative materials used in dentistry. It illustrates the terms and principles involved in describing the clinical behaviour of these materials based on their physical, chemical, and mechanical properties. It also highlights the knowledge of appreciation of certain biological considerations for use of dental materials in oral cavity and hazards associated with them.

Aims

The section aims to provide basic background knowledge regarding structure of matter and to provide a comprehensive account of relationship between general properties of dental materials and their clinical performance. Another aspect of importance is the potential of this information to predict clinical performance under biological limitations and to allow the students to develop a critical understanding of the factors that determine the safe and correct use of materials in dentistry.

Learning outcomes

By the end of a unit, candidates will be able to:

- 1. Classification and overview of different preventive and restorative materials**
 - Understand basic classification of dental materials *i.e.* metals, ceramics, polymers and composites.
- 2. Structure of matter and principles of adhesion**
 - Describe the structure of matter and explain the principles of adhesion among dental materials.

3. Physical and chemical properties related to material sciences

- Demonstrate knowledge of the fundamental biological, chemical, and physical principles that make the foundation of the clinical behaviour and application of dental materials.

4. Surface chemistry

- Understand the principles involving surface interaction of dental materials in biological environment.

5. Biocompatibility

- Demonstrate knowledge of the range of biological consideration regarding the selection and performance of dental materials for clinical applications.
- Understand the knowledge of safety, biocompatibility, and biomechanics as they relate to the correct clinical use of dental materials.

SECTION II DIRECT RESTORATIVE MATERIALS

This section familiarises students with several key themes and subjects regarding different types of direct restorative materials used in dentistry. It is designed to provide detailed information regarding historical background, types, properties, biological consideration, clinical applications, limitations, and selection criteria of direct restorative materials.

Aims

The aim of this section is to allow students to develop scientific knowledge, understanding and competence in direct restorative materials. Based on the information regarding their clinical behaviour and selection criteria students will be able to grasp the scientific rationale for use of these materials for their clinical applications.

Learning outcomes

By the end of a unit, candidates will be able to:

- Understand basic classification and types of direct restorative dental materials *i.e.* dental amalgam, dental cements and resin based composites.
- Understand the basic nature, classification, types, composition, properties, and manipulation of direct restorative materials.

- Differentiate between the various types of direct restorative materials and their respective properties.
- Identify and manipulate different direct restorative materials commonly used in dentistry for restorative and lab procedures.
- Learn the process of selection criteria for direct restorative materials.
- Understand the risks and hazards associated with the use of direct restorative materials.
- Understand the technological advances and current trends in direct restorative materials.

1. Dental amalgam

- Describe the history, composition, and classification of dental amalgams.
- Understand the setting mechanism of different types of dental amalgams.
- Understand and explain the properties of dental amalgams.
- Understand and demonstrate clinical manipulation and factors affecting the properties of dental amalgams.
- Understand the issues related to amalgam hygiene in clinical practice.
- Explain the biocompatibility issues relating to dental amalgams.
- Identify recent advancements in dental amalgams.

2. Dental cements

- Understand the objectives and basic terminologies related to dental cements.
- Understand the general requirements, types, and properties of different dental cements.
- Understand and explain the setting mechanism of different dental cements.
- Understand and explain the properties, advantages, and disadvantages of different dental cements.
- Understand and describe the clinical applications of different dental cements.
- Understand the concept of bases and liners for different clinical applications.
- Describe luting agents, types, and their properties.

- Understand the use of temporary restorative materials, properties, and their uses.
- Demonstrate techniques for handling and manipulation of various dental cements.
- Define Atraumatic Restorative Technique (ART) and its uses.

3. Restorative resin composite

- Describe the history and classification of restorative composites.
- Understand and describe the properties of different components of restorative composites.
- Understand the characteristics and clinical applications for composite restorative materials.
- Understand and explain different modifications in relation to restorative composites.
- Understand finishing and polishing procedures for restorative composites.
- Understand the biocompatibility issue related to restorative composites.
- Understand the recent advancements in restorative composites.
- Demonstrate clinical manipulation of restorative composites.

4. Denting bonding agents and adhesive dentistry

- Understand the concept of bonding and adhesion in dentistry.
- Define enamel and dentine bonding.
- Understand the significance and rationale behind enamel and dentine bonding.
- Understand various types and generations of bonding agents.
- Understand the significance of biodegradation of restorative resins.
- Understand and explore recent advancements in dentin bonding agents.

SECTION III INDIRECT RESTORATIVE MATERIALS

The section covers detailed information regarding the physical, chemical, and biological properties, manipulation and handling characteristics of indirect restorative materials used in dentistry. This includes detailed study of scientific and clinical properties of materials such as dental acrylic resins, dental ceramics and metals used in restorative dentistry.

Aims

The aim of this section is to allow students to develop scientific knowledge, understanding and competence in direct restorative materials. Based on the information regarding their clinical behaviour and selection criteria students will be able to grasp the scientific rationale for use of these materials for their clinical applications.

Learning outcomes

By the end of a unit, candidates will be able to:

- Understand basic classification and types of indirect restorative dental materials.
- Understand the basic nature, classification, types, composition, properties, and manipulation of indirect restorative materials.
- Differentiate between the various types of indirect restorative materials and their respective properties.
- Identify and manipulate different indirect restorative materials commonly used in dentistry for restorative and lab procedures.
- Learn the process selection criteria for indirect restorative materials.
- Understand the risks and hazards associated with the use of indirect restorative materials.
- Understand the technological advances and current trends regarding indirect restorative materials.

1. Denture base acrylic resins

- Understand the definition of denture base materials.
- Understand the ideal properties and types of denture base materials.
- Understand the chemical composition and properties of denture base materials.
- Understand the various procedures involved in the fabrication of denture base materials.
- Understand and discuss clinical application, manipulation, processing, and care of dentures for laboratory processed prosthetic resins.
- Understand and describe biocompatibility issues associated with denture base materials.
- Describe various methods of polymerisation of denture base materials.

2. Denture relining and rebasing materials

- Understand relining and rebasing procedures for dentures.
- Describe various types of relining and rebasing dental materials.
- Describe manipulation and properties of relining and rebasing materials.
- Understand biocompatibility issues associated with relining and rebasing materials in dentistry.

3. Tissue conditioners

- Understand the definition tissue conditioners.
- Understand various types of tissue conditioners used in dentistry.
- Understand and discuss the properties of various tissue conditioners used in dentistry.
- Understand the steps of clinical manipulation of tissue conditioners.

4. Dental ceramics

- Understand the basic chemistry and composition of ceramics.
- Understand the composition and classification of different dental ceramics systems.
- Understand general procedures involved in fabrication of dental ceramics.
- Understand the concept of metal ceramic bonding.
- Understand metal ceramic restorations, their uses and properties.
- Understand all ceramic restoration, their uses and properties.
- Describe methods of strengthening ceramics.

5. Metals used in dentistry

- Understand the basic concepts related to processing and solidification of dental alloys.
- Understand different types of metals and alloys used in fabrication of dental prosthesis.
- Understand the alloy phase diagrams.

- Explain the types, processing, and clinical applications of high noble and noble metal alloys.
- Explain the types, processing, and clinical applications of base metal alloys.
- Explain the casting procedures for metal alloys.
- Explain the types, processing, and clinical applications of wrought metal alloys.
- Explain the types, processing, and clinical applications of stainless steel in dentistry.
- Understand the significance and clinical applications for titanium and its alloys in dentistry.
- Describe the properties and composition of various orthodontic wires.

6. Soldering and welding

- Understand the objectives and uses of soldering and welding in dentistry.
- Understand the differences between soldering, brazing and welding.
- Describe the components of dental solders and welding.
- Understand different heat sources for soldering and welding.
- Understand welding and its types.

7. Dental implants

- Describe the history of implants in dentistry.
- Define osseointegration and its factors affecting it.
- Explain different types of implants used in dentistry.
- Understand materials used for dental implants.

SECTION IV AUXILIARY DENTAL MATERIALS

The section provides information regarding variety of auxiliary dental materials used in dentistry. Auxiliary dental materials include a range of materials that are involved in the fabrication of different dental prosthesis but that do not become part of the prosthesis.

Aims

The section aims to develop knowledge regarding basic features of auxiliary dental materials used in clinical and laboratory procedures. It involves the study of composition, properties, manipulation of auxiliary dental materials and the way they interact with the environment in which they are applied.

Learning outcomes

By the end of a unit, candidates will be able to:

1. Gypsum products

- Understand the properties, types, uses, and manipulation of gypsum products.
- Understand the method of manufacturing and properties of gypsum products used in dentistry.
- Understand the setting reactions of different types of dental gypsum products.
- Understand the manipulation factors that affect the setting time and physical and mechanical properties of gypsum products.
- Understand and demonstrate the methods used for the disinfection of dental gypsum models and study casts.
- Understand and demonstrate the proper mixing technique of dental gypsum used for preparing study models and casts.

2. Impression materials

- Understand the significance of impression and impression materials in dentistry.
- Understand the general requirements for an ideal impression material.
- Understand the classification, characteristics, and properties of elastic and non-elastic impression materials.
- Compare the properties and clinical application of different types of impression materials.
- Understand and demonstrate proper technique for mixing, handling, and manipulation of the elastic and non-elastic impression materials.

3. Dental waxes

- Understand the classification and types of waxes used in dentistry.
- Discuss the composition, properties, and application of different types of dental waxes.
- Understand and demonstrate manipulation of different types of dental waxes.

4. Casting investments and casting procedures

- Define and explain investment materials used in dentistry.
- Understand different types of investment materials used in dentistry.
- Understand the composition, setting reaction and properties of gypsum bonded investment.
- Understand the composition, setting reaction and properties of phosphate bonded investment.
- Understand the composition, setting reaction and properties of silica bonded investment.
- Understand and compare properties and clinical applications of different types of investments.
- Understand the steps and methods involved in casting procedures.

5. Finishing and polishing materials

- Understand the objectives for finishing and polishing of dental restorations and prosthesis.
- Understand the classification, composition, properties of abrasives and clinical applications for finishing and polishing materials.
- Understand the principles of finishing and polishing of dental materials.
- Understand different types of cutting and abrasive instruments.
- Describe biological hazards associated with dental abrasive and polishing materials.

6. Separating media

- Understand the rationale behind the use of separating media in dentistry.
- Describe and identify various types of separating media used in dentistry, including their composition, mechanism of action and properties.

- Understand and demonstrate the steps involved in manipulation of separating media.
- Understand the techniques for application of a separating media.

SECTION V PREVENTIVE DENTAL MATERIALS

The section deals with the introduction and knowledge of various preventive materials used in dentistry. It describes different types of preventive dental materials associated with mechanical tooth cleaning, plaque control, fluorides, and fissure sealants.

Aims

The section aims to introduce students to basic preventive dental materials used in clinical dentistry. It involves the study of composition, properties, manipulation of preventive dental materials and the criteria for proper selection for their clinical application.

Learning outcomes

By the end of a unit, candidates will be able to:

1. Dentifrices

- Understand the types, composition and purpose of dentifrices and mouthwashes.

2. Fluoride agents

- Understand and identify different types of fluoride agents, their mode of action and application.

3. Pit and fissure sealants

- Understand the composition, properties, manipulation and clinical application of pit and fissure sealants.

SECTION VI ENDODONTIC MATERIALS

The section focuses on the material used in endodontics that are used to irrigate and disinfect, obturate and seal the root canal system during endodontic treatment.

Aims

The section introduces students to different types of endodontic materials classified according to their intended clinical uses. It involves the study of composition, properties and mode of application of various disinfectants, lubricants, sealants and obturating materials used in endodontics.

Learning outcomes

By the end of a unit, candidates will be able to:

- Define endodontics and classify different endodontic materials used.
- Understand steps for performing endodontic procedures.
- Understand the use of different irrigants and lubricants used in endodontics.
- Understand the use of various root canal medicaments.
- Understand different obturating materials.
- Understand the role of mineral trioxide aggregate (MTA) and other retrograde filling materials.

SECTION VII LABORATORY PRACTICALS

The practical component covers the manipulative and applied aspects of dental material science.

Aims

The laboratory practical component serves to familiarize students with the range of materials used in dentistry. It involves hands on experience with the materials so that students can understand issues related to dispensing, handling, manipulation, and practical application of dental materials.

Learning outcomes

Upon completion, students should be able to identify different materials used in dentistry and understand the proper procedures for their manipulation, safety, and infection control.

1. Introduction to laboratory equipment

- Identify and familiarise with instruments and equipment required for handling and manipulation of different dental materials in laboratory.

2. Gypsum products

- Identify different types of gypsum products.
- Demonstrate the correct dispensing ratio of different gypsum products.
- Demonstrate the correct mixing technique for gypsum products.
- Making plaster slab.

3. Impression materials

- Identify different types of impression materials.
- Demonstrate the correct dispensing, manipulation, and application of:
 - i. Alginate
 - ii. ZnO-eugenol paste
 - iii. Impression compound
 - iv. Elastomeric impression materials

4. Dental waxes

- Identify different types of dental waxes.
- Demonstrate the manipulation and application of different:
 - i. Pattern waxes
 - ii. Processing waxes
 - iii. Impression waxes

5. Acrylic resins

- Demonstrate the correct dispensing, manipulation and application of self-cure and heat-cure dental acrylic resin.

6. Dental amalgam

- Demonstrate the correct dispensing, trituration, and application of dental amalgam.
- Demonstrate hand mixing and mechanical mixing of dental amalgam.

7. Dental cements

- Identify different types of dental cements.
- Demonstrate the correct dispensing, mixing and application of:
 - i. Zinc phosphate cement
 - ii. Zinc oxide eugenol cement
 - iii. Glass ionomer cement
 - iv. Calcium hydroxide cement

8. Restorative composite resins

- Identify and familiarise with the armamentarium used for composite restorations i.e.
 - i. Visible light cure unit
 - ii. Acid etching gel
 - iii. Bonding agent
 - iv. Restorative composite
- Demonstration of different steps in composite restoration on extracted teeth.
- Demonstration of steps in sandwich technique on extracted teeth.

9. Metals and alloys

- Identification of different indirect metallic restorations.
- Identification of different orthodontic wire used in dentistry.

10. Dental ceramics

- Identification of different ceramic restorations

11. Investment materials

- Identification of different types of investment materials

12. Endodontic materials

- Identification of different endodontic materials used in dentistry.

13. Finishing and polishing materials

- Identification of different abrasives used in finishing and polishing procedures.

LEARNING RESOURCES

I. General classes and properties of dental materials	<ol style="list-style-type: none">1. Anusavice, Kenneth J., Chiayi Shen, and H. Ralph Rawls. <i>Phillips' science of dental materials</i>. Elsevier Health Sciences, 2013. 12th Edition.2. Powers, John M., and Ronald L. Sakaguchi. <i>Craig's restorative dental materials</i>, 13/e. Elsevier India, 2006.3. McCabe, John F., and Angus WG Walls, eds. <i>Applied dental materials</i>. John Wiley & Sons, 2013.
II. Direct restorative materials	<ol style="list-style-type: none">1. Anusavice, Kenneth J., Chiayi Shen, and H. Ralph Rawls. <i>Phillips' science of dental materials</i>. Elsevier Health Sciences, 2013. 12th Edition.2. Powers, John M., and Ronald L. Sakaguchi. <i>Craig's restorative dental materials</i>, 13/e. Elsevier India, 2006.3. McCabe, John F., and Angus WG Walls, eds. <i>Applied dental materials</i>. John Wiley & Sons, 2013.
III. Indirect restorative materials	<ol style="list-style-type: none">1. Anusavice, Kenneth J., Chiayi Shen, and H. Ralph Rawls. <i>Phillips' science of dental materials</i>. Elsevier Health Sciences, 2013. 12th Edition.2. Powers, John M., and Ronald L. Sakaguchi. <i>Craig's restorative dental materials</i>, 13/e. Elsevier India, 2006.3. McCabe, John F., and Angus WG Walls, eds. <i>Applied dental materials</i>. John Wiley & Sons, 2013.

<p style="text-align: center;">IV. Auxillary dental materials</p>	<ol style="list-style-type: none"> 1. Anusavice, Kenneth J., Chiayi Shen, and H. Ralph Rawls. <i>Phillips' science of dental materials</i>. Elsevier Health Sciences, 2013. 12th Edition. 2. Powers, John M., and Ronald L. Sakaguchi. <i>Craig's restorative dental materials</i>, 13/e. Elsevier India, 2006. 3. McCabe, John F., and Angus WG Walls, eds. <i>Applied dental materials</i>. John Wiley & Sons, 2013.
<p style="text-align: center;">V. Preventive dental materials</p>	<ol style="list-style-type: none"> 1. Anusavice, Kenneth J., Chiayi Shen, and H. Ralph Rawls. <i>Phillips' science of dental materials</i>. Elsevier Health Sciences, 2013. 12th Edition. 2. Powers, John M., and Ronald L. Sakaguchi. <i>Craig's restorative dental materials</i>, 13/e. Elsevier India, 2006. 3. McCabe, John F., and Angus WG Walls, eds. <i>Applied dental materials</i>. John Wiley & Sons, 2013.
<p style="text-align: center;">VI. Endodontic materials</p>	<ol style="list-style-type: none"> 1. Anusavice, Kenneth J., Chiayi Shen, and H. Ralph Rawls. <i>Phillips' science of dental materials</i>. Elsevier Health Sciences, 2013. 12th Edition. 2. Powers, John M., and Ronald L. Sakaguchi. <i>Craig's restorative dental materials</i>, 13/e. Elsevier India, 2006. 3. McCabe, John F., and Angus WG Walls, eds. <i>Applied dental materials</i>. John Wiley & Sons, 2013.

OTHER LEARNING RESOURCES

<p>Laboratory Demonstrations/ Hands-on activity</p>	<p>The laboratory demonstrations familiarize students with the clinical application of different materials used in dentistry. It provides hands on experience for the students to understand and practice dispensing, handling, manipulation, and practical application of dental materials</p>
<p>Videos</p>	<p>Videos related to the dispensing, handling and correct application of various dental materials are used to introduce the practical aspect of science of dental materials</p>
<p>Self-Learning</p>	<p>Self-learning enables the student to drive their own learning process. Students are directed to search the information from different resources in order to prepare for small group discussions and tutorials.</p>

SUMMATIVE ASSESSMENT METHODS AND POLICIES

Internal Assessment (IA)

- a. Weightage of internal assessment shall be 20 %, each for theory and practical, in BDS Professional Examination.
- b. The Internal Assessment shall comprise of Block Examination / assignments / class presentation / send-ups /class tests / OSPE etc.
- c. The Internal Assessment record shall be kept in the respective department of the College / Institute and after approval of Principal, a summary as per university registration number shall be furnished to the Controller of Examinations, at least two weeks before the commencement of final examination.
- d. The result of all the class tests / tools which contribute towards IA will be displayed to the students during an academic year.
- e. The same internal assessment shall be counted both for annual and supplementary examinations. The students who are relegated, however, can improve the internal assessment during subsequent year.
- f. Internal assessment tools of any subject may be changed after the approval of respective FBS

Annual Examination

- a. The weightage of Annual Examination shall be 80%, each for theory and practical, in BDS.
- b. The examination comprises of a theory paper and practical/clinical examinations as per PMDC regulations and the Table of Specifications (TOS) of the University.
- c. The gap between two consecutive theory papers shall not be more than two days.
- d. The Theory Paper shall be of 3-hours duration, held under the arrangements of the university. It shall have two parts; MCQs and SAQs for the year 2023. It may be changed after the approval of Academic Council.

• Internal Examiner

He/she shall be Associate Professor/Professor and Head of Department who has been involved in teaching of the class being examined for at least six months and has delivered 50% of the total lectures. Second preference shall be Associate/Assistant Professor who is involved in teaching of the class and posted there for one year. Third preference shall be a recognised Professor of the subject.

- **External Examiner**

He/she shall be a Professor/Associate Professor of a recognised Medical/Dental College or at least an Assistant Professor with three years teaching experience in the relevant subject.

- **Conflict of Interest**

No person shall serve as an examiner whose close relative (wife, husband, son, daughter, adopted son, adopted daughter, grand-son, grand-daughter, brother, sister, niece /nephew, son and daughter- in-law brother and sister- in-law, parental and maternal uncle and aunt *etc.*) is appearing in the examination. All examiners likely to serve as an examiner shall render a certificate in compliance to this para.

- **Paper Setting**

- a. Each College / Institute shall forward a set of two question papers as per TOS along with the key for each subject to the Controller of Examinations, at least three months in advance of the annual examination. The question paper as a whole / a question without a comprehensive key shall not be considered towards final paper setting.
- b. The set of question papers shall be prepared by the respective Head of Department (HoD) and furnished to Controller of Examinations through Head of Institution (HoI)
- c. The Controller of Examinations shall approve the faculty for the final paper setting having fair representation of each college / institute.

- **Paper Assessment**

- a. The Controller of Examinations shall approve the faculty for the theory paper marking, to be undertaken in the manner as deemed appropriate.
- b. The Examination Directorate shall coordinate directly with the faculty, earmarked for the paper marking.
- c. A student who scores 85% and above marks in any subject shall qualify for distinction in that particular subject.
- d. A fraction in aggregate marks of a subject shall be rounded off to whole number. If it is less than 0.5 then it will be rounded off to the previous whole number while 0.5 or more will be rounded off to the next whole number.

- **Practical Examinations**

- a. The Controller of Examinations shall approve the faculty to serve as the internal & external examiners.
- b. The number of external and internal examiners shall be equal.
- c. One external& internal examiner each shall be marked for a group of 100 students.

- d. Candidates may be divided into groups practical examinations and be standardised by incorporating OSPE stations.
- e. Practical examination shall be held after the theory examination of the subject but in special cases, it may be held before the theory examination with the approval of the Controller of Examinations. For the purpose of practical/clinical examination, the candidates may be divided into subgroups by the examiners.
- f. The assessment of the practical examination duly signed by internal & external examiner shall be furnished to the Controller of Examinations within one week of the conclusion of examination.

- **Pass Marks**

- a. Pass marks for all subjects shall be 50 % in theory and practical, separately.
- b. No grace marks shall be allowed to any student in any examination.

- **Declaration of Result**

Every effort shall be made to declare the result of each examination within one month of the last practical examination or earlier.

- **Promotion**

No student shall be promoted to the higher classes unless he/she passes all the subjects of the previous class.

- **Re-totaling**

Any student may apply to the Controller of Examinations on a prescribed form along with the specified fee.

- **Supplementary Examination**

The interval between a supplementary examination and the previous professional examination shall not be more than two months. There shall be no special supplementary examination.

- **Academic Audit**

The Vice Chancellor may get any academic matter deliberated in the manner as deemed appropriate.

- **Issue of Academic Transcript/Detailed Marks Sheet**

A student desirous of obtaining Academic Transcript / Detailed Mark Sheet may apply to Controller of Examinations along with the prescribed fee for each original copy.

- **Withdrawal/Failure**

Any student who fails to clear the first Professional in BDS or first in four chances, availed or un-availed, shall be expelled as per PM& DC policy and shall not be eligible for fresh admission as a fresh candidate in either BDS.

SCIENCE OF DENTAL MATERIALS

Proposed Table of Specifications for Annual Professional Examination 2023: Theory

Theory

Marks of theory paper	= 80
Time Allowed	= 03 hrs
Internal assessment (20%)	= 20
Total Marks (MCQs:40%+SEQs:40%+IA:20%)	= 100
Pass Marks	= 50

Paper-1: (*Marks of MCQ component shall be rationalized to 40% weightage)

Paper-2:

8x SEQs/SEQS (05 Marks Each) (40 Marks) Time = 120 min

*If a candidate obtains 50 marks in MCQs it will be rationalized as: $(50/60 \times 40 = 33.33)$

Sr.	Topics and Subtopics	Number of MCQs (60)		Number of SEQs/SAQs = 08 (8x5 Marks)
		Recall=36	Application=24	
1.	General Classification and Properties of Dental Materials	8		
	➤ Properties Used to Characterize Materials	4	3	1
	➤ Requirements of Direct Filling Materials and Historical Perspectives	1	----	---
2.	Dental Amalgam	3		
	➤ Dental Amalgam	2	1	1
3.	Impression Materials	8		
	➤ Impression Materials: Classification and Requirements	1		1
	➤ Non-Elastic Impression Materials	1	2	
	➤ Elastic Impression Materials: Hydrocolloids	2		
	➤ Elastic Impression Materials: Synthetic Elastomers	1	1	
4.	Waxes, Gypsum Products and Investment Materials *	6		
	➤ Gypsum Products for Dental Casts	1	1	1*
	➤ Dental Waxes	1	1	
	➤ Investment and Refractory Dies	1	1	

5.	Prosthetic Polymers and Associated Materials *	6		
	➤ Prosthetic Polymers • Synthetic Polymers	1		1*
	• Denture Base Polymers	1	1	
	• Denture Lining Materials	1	1	

	➤ Artificial Teeth ➤ Other Auxiliary Materials: Separating Media	1		
6.	Resin-based Materials	6		
	➤ Resin-Based Filling Materials	2	1	1
	➤ Bonding of Resin-Based Materials	2	1	
7.	Ceramics and Casting Procedures	6		
	➤ Ceramics and Porcelain Fused to Metal (PFM)	2	1	1
	➤ Casting	2	1	
8.	Metals in Dentistry	8		
	➤ Metallurgy Concepts and Applications (Including Base Metal, Gold, Noble Metals, Steel and Wrought Alloys)	4	3	1
	➤ Dental Implants		1	
9.	Cements	6		
	➤ Concept of Lining, Base and Luting Applications		1	1
	➤ Glass Ionomer Restorative Materials (Polyalkenoates)		1	
	➤ Modifications in GIC (RMGIC and Related Materials)		1	
	➤ Cements Based on Phosphoric Acids	1		
	➤ Cements Based on Organometallic Chelates	1		
	➤ Polycarboxylates	1		
10.	Miscellaneous Topics	3		
	Miscellaneous Topics			---
	Endodontic Materials	1		
	Preventive Materials	1		
	Dentifrices Fluoride Agents Pit and Fissure Sealants		1	
	TOTAL	60 (60 Marks)		08 (40 Marks)
	*1 SEQ can come from either Sr. 4 or 5			

Internal Assessment Calculation (Theory-Annual)-10 Marks

Exams	Division	Percentage	Weightage
End-of-Block and Pre-annual Exams	End of Block Exam-I	20	80
	End of Block Exam-II	20	
	Pre-Annual Exam	40	

Class Performance	Class Tests	20	20
Total			100%

Table of specifications for Annual Professional Exam: Practical

VIVA 40 marks		Practical (OSPE + Wire Work + Assignment) 40 marks			Total
Examiner 1	Examiner 2	OSPE	Wire Work	Assignment	80 Marks
20 Marks	20 Marks	30 Marks	05 Marks	05 Marks	

Internal Assessment Calculation (Practical-Annual)-10 Marks

Exams	Division	Percentage	Weightage
End-of-Block and Pre-annual Exams	OSPE/PPT/Assignments	60	80
	Pre-Annual Practical	20	
Class Performance	SGD/PBL/CBL/Class activity	20	20
Total			100%

SAMPLE THEORY PAPER QUESTIONS

Sample MCQ

A rheological effect of metals and other solid materials that may become plastically deformed because of a load being applied for a long period:

- a) Fatigue strength
- b) Toughness
- c) Resilience
- d) Creep

Key: d

Short Essay Questions (SEQs)

- Short essay questions require students to present written answers that are used to assess basic knowledge of key facts and provide students with an opportunity to demonstrate reasoning and explain their understanding of the subject.

Sample SEQ

Q. a) Classify gypsum products. Enumerate the factors that control setting time of gypsum (4)

b) Write the composition of dental stone plaster (3)

Key:

a) Classification:

Type I Impression plaster

Type II Model plaster

Type III Dental stone

Type IV Dental stone, High strength

Type V Dental stone, High strength High expansion

Factors affecting setting time of gypsum:

1. Water/powder ratio
2. Temperature
3. Speed of spatulation
4. Aging
5. Particle size
6. Impurities
7. Retarders

b) Composition:

Calcium sulphate hemihydrate Main ingredient

Potassium sulphate Accelerator, Anti-expansion agent

Borax Retarder

Alizarin red Coloring agent

Gum tragacanth Improve cohesiveness

Starch Soluble plaster