সিলেবাস বন্টন - 2022

স্নাতকোত্তর ২য় সেমেস্টার				
BNG 201	BNG 202	BNG 203	BNG 204 (CBCS)	BNG 205
সাধারণ ভাষাবিজ্ঞান (GUEST)	মেঘনাদবধ কাব্য (D.M.)	শ্যামলী (A.B.)	ভাষাতত্ত্ব (S.C.)	সেমিনার ও গবেষণাধর্মী প্রকল্প রচনা (ALL TEACHERS)
	বনলতা সেন (S.R.)	রক্তকরবী (B.K.)	চর্যাপদ (D.M.)	
	আধুনিক কবিতা (S.C.)	চতুরঙ্গ (S.R.)	মধ্যযুগ (B.K.)	
		রবীন্দ্র ছোটগল্প (D.M.)	প্রহসন (A.B.)	

স্নাতকোত্তর ৪র্থ সেমেস্টার					
BNG 401	BNG 402	BNG 403	BNG 404	BNG 405 (F)	BNG 405 (E)
রজনী (B.K.)	প্রাচ্য সাহিত্যতত্ত্ব & সাহিত্যদর্পণ (GUEST)	ক) রোমান্টিক মুভমেন্ট,হিস্টরিকাল ক্রিটিসিজম, কম্পারেটিভ ক্রিটিসিজম, সাব-অল্টার্ন কনসেপ্ট, , পোস্ট স্ট্রাকচারলিজম, সাইকোঅ্যানালাইসিস (D.M.) খ) ফেমিনিজম (S.R.)	ভাষা আন্দোলন (S.R.)	বাংলা উপন্যাসের রূপ-রীতি (S.R.)	লোকসংস্কৃতি A.B.
মধুসূদন, রবীন্দ্রনাথ, জীবনানন্দের উপর প্রাচ্য ও পাশ্চাত্য প্রভাব (B.K.)			বিহার ও ঝাড়খণ্ডের বাংলা সাহিত্যচর্চা (D.M.)	শ্রীকান্ত (B.K.)	
মেঘদূত (A.B.)	রবীন্দ্রনাথের সাহিত্যতত্ত্ব (S.C.)	পোয়েটিকস (S.C.)	আসাম ও ত্রিপুরার বাংলা ভাষা চর্চা (B.K. /GUEST)	হাঁসুলী বাঁকের উপকথা (S.R.)	
		অন দ্য আর্থ অফ পোয়েট্রি (S.C.)		ছোটগল্প (D.M. & B.K.)	

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স্নাতক ২য় সেমেস্টার (সাম্মানিক এবং সাধারণ)				স্নাতক ৪র্থ সেমেস্টার (সাম্মানিক এবং সাধারণ)							
সাম্মানিক		সাধারণ		সাম্মানিক				সাধারণ			
CC3	CC4	DSC 1B (কাব্য - কবিতা)	AECC (কবিতা ও ছোটগল্প)	CC8	CC9	CC10	SEC 2	GE 4 (বাংলা গীতিসাহিত্য, শিশুসাহিত্য, রম্যরচনার ধারা	DSC 1D (সাহিত্যতত্ত্ব ও সাহিত্য নির্মাণ কলা)	SEC 2 (অনুবাদতত্ত্ব ও সৃজনশীল রচনা)	AECC (উনিশ শতকের বাংলা প্রবন্ধ ও লোকসাহিত্য)
চর্যাপদ (D.M)	চৈতন্যভাগবত (S.C.)	বৈষ্ণব পদাবলী (D.M.)	বাংলা কবিতা ও বাংলা ছোটগল্প (D.M)	উনিশ ও বিশ শতকের নাট্য সাহিত্যের ইতিহাস (A.B.)	বীরাঙ্গনা কাব্য (S.C.)	কপালকুণ্ডলা (D.M.)	বাংলা ভাষা ও সাহিত্য বিষয়ক প্রকল্প রচনা ও প্রকল্পের উপস্থাপনা (ALL TEACHERS)	বাংলা গীতি সাহিত্য ধারা (A.B.)	রস ও ধ্বনি (A.B.)	বাংলা ধ্বনিতত্ত্ব ও রূপতত্ত্ব (B.K.))	উনিশ শতকের বাংলা প্রবন্ধ ও লোকসাহিত্য (D.M.)
বৈষ্ণব পদাবলী (S.R.)	চণ্ডীমঙ্গল (B.K.)	শাক্ত পদাবলী (B.K.)		উনিশ ও বিশ শতকের উপন্যাসের ইতিহাস (S.R.)	বলাকা (D.M.)	শেষের কবিতা (S.C.)		বাংলা শিশু সাহিত্যের ধারা (D.M.)	ছন্দ (B.K.)		
শাক্ত পদাবলী (A.B.)	অন্নদামঙ্গল (D.M.)	বীরাঙ্গনা কাব্য (B.K.)		উনিশ ও বিশ শতকের ছোটগল্পের ইতিহাস (B.K.)	বনলতা সেন (S.R.)	কবি (A.B.)		রম্যরচনার ধারা (D.M.)	অলঙ্কার (B.K.)		
		আধুনিক কবিতা সংকলন (D.M.)		ছোটগল্প পাঠ (B.K.)							

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স্নাতকোত্তর ২য় সেমেস্টার				
BNG 201	BNG 202	BNG 203	BNG 204 (CBCS)	BNG 205
সাধারণ ভাষাবিজ্ঞান (GUEST)	মেঘনাদবধ কাব্য (D.M.)	শ্যামলী (A.B.)	ভাষাতত্ত্ব (S.C.)	সেমিনার ও গবেষণাধর্মী প্রকল্প রচনা (ALL TEACHERS)
	বনলতা সেন (S.R.)	রজকরবী (B.K.)	চর্যাপদ (D.M.)	
	আধুনিক কবিতা (S.C.)	চতুরঙ্গ (S.R.)	মধ্যযুগ (B.K.)	
		রবীন্দ্র ছোটগল্প (D.M.)	প্রহসন (A.B.)	

স্নাতকোত্তর ৪র্থ সেমেস্টার					
BNG 401	BNG 402	BNG 403	BNG 404	BNG 405 (F)	BNG 405 (E)
রজনী (B.K.)	প্রাচ্য সাহিত্যতত্ত্ব & সাহিত্যদর্পণ (GUEST)	ক) রোমান্টিক মুভমেন্ট,হিস্টরিকাল ক্রিটিসিজম, কম্পারেটিভ ক্রিটিসিজম, সাব-অল্টার্ন কনসেপ্ট, , পোস্ট স্ট্রাকচারালিজম, সাইকোঅ্যানালাইসিস (D.M.) খ) ফেমিনিজম (S.R.)	ভাষা আন্দোলন (S.R.)	বাংলা উপন্যাসের রূপ-রীতি (S.R.)	লোকসংস্কৃতি A.B.
মধুসূদন, রবীন্দ্রনাথ, জীবনানন্দের উপর প্রাচ্য ও পাশ্চাত্য প্রভাব (B.K.)			বিহার ও ঝাড়খণ্ডের বাংলা সাহিত্যচর্চা (D.M.)	শ্রীকান্ত (B.K.)	
মেঘদূত (A.B.)	রবীন্দ্রনাথের সাহিত্যতত্ত্ব (S.C.)	পোয়েটিকস (S.C.)	আসাম ও ত্রিপুরার বাংলা ভাষা চর্চা (B.K. /GUEST)	হাঁসুলী বাঁকের উপকথা (S.R.)	
		অন দ্য আর্থ অফ পোয়েট্রি (S.C.)		ছোটগল্প (D.M. & B.K.)	

স্নাতক ২য় সেমেস্টার (সাম্মানিক এবং সাধারণ)				স্নাতক ৪র্থ সেমেস্টার (সাম্মানিক এবং সাধারণ)							
সাম্মানিক		সাধারণ		সাম্মানিক				সাধারণ			
CC3	CC4	DSC 1B (কাব্য - কবিতা)	AECC (কবিতা ও ছোটগল্প)	CC8	CC9	CC10	SEC 2	GE 4 (বাংলা গীতিসাহিত্য, শিশুসাহিত্য, রম্যরচনার ধারা	DSC 1D (সাহিত্যতত্ত্ব ও সাহিত্য নির্মাণ কলা)	SEC 2 (অনুবাদতত্ত্ব ও সৃজনশীল রচনা)	AECC (উনিশ শতকের বাংলা প্রবন্ধ ও লোকসাহিত্য)
চর্যাপদ (D.M)	চৈতন্যভাগবত (S.C.)	বৈষ্ণব পদাবলী (D.M.)	বাংলা কবিতা ও বাংলা ছোটগল্প (D.M)	উনিশ ও বিশ শতকের নাট্য সাহিত্যের ইতিহাস (A.B.)	বীরাঙ্গনা কাব্য (S.C.)	কপালকুণ্ডলা (D.M.)	বাংলা ভাষা ও সাহিত্য বিষয়ক প্রকল্প রচনা ও প্রকল্পের উপস্থাপনা (ALL TEACHERS)	বাংলা গীতি সাহিত্য ধারা (A.B.)	রস ও ধ্বনি (A.B.)	বাংলা ধ্বনিতত্ত্ব ও রূপতত্ত্ব (B.K.))	উনিশ শতকের বাংলা প্রবন্ধ ও লোকসাহিত্য (D.M.)
বৈষ্ণব পদাবলী (S.R.)	চণ্ডীমঙ্গল (B.K.)	শাক্ত পদাবলী (B.K.)		উনিশ ও বিশ শতকের উপন্যাসের ইতিহাস (S.R.)	বলাকা (D.M.)	শেষের কবিতা (S.C.)		বাংলা শিশু সাহিত্যের ধারা (D.M.)	ছন্দ (B.K.)		
শাক্ত পদাবলী (A.B.)	অন্নদামঙ্গল (D.M.)	বীরাঙ্গনা কাব্য (B.K.)		উনিশ ও বিশ শতকের ছোটগল্পের ইতিহাস (B.K.)	বনলতা সেন (S.R.)	কবি (A.B.)		রম্যরচনার ধারা (D.M.)	অলঙ্কার (B.K.)		
		আধুনিক কবিতা সংকলন (D.M.)		ছোটগল্প পাঠ (B.K.)							

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স্নাতক ৬ষ্ঠ সেমেস্টার সাম্মানিক ও সাধারণ

সাম্মানিক				সাধারণ		
CC13	CC14	DSE3 (গদ্য সাহিত্য পাঠ)	DSE4 (উপন্যাস)	GE2 (প্রবন্ধ ও সাহিত্যের রূপ-রীতি বিচার পদ্ধতি)	DSE1B (উপন্যাস ও ছোটগল্প)	SEC4
লোকসাহিত্যের সংজ্ঞা, স্বরূপ ও বৈশিষ্ট্য (A.B.)	সংস্কৃত সাহিত্যের ইতিহাস (S.R.)	আলালের ঘরের দুলাল (A.B.)	পুতুল নাচের ইতিকথা (S.R.)	নির্বাচিত প্রবন্ধ (B.K.)	রাধা (A.B.)	বিষয় ভিত্তিক আলোচনা ও আলোচনাপত্র উপস্থাপন (A.B.)
মহুয়া পালা (B.K.)	ইংরেজি সাহিত্যের ইতিহাস (S.C.)	কমলাকান্তের দপ্তর (S.C.)	তুঙ্গভদ্রার তীরে (D.M.)	সাহিত্যের রূপ-রীতি (A.B.)	ছোটগল্প (B.K.)	
বাংলার ব্রত (A.B.)	অন্যান্য প্রতিবেশী সাহিত্যের ইতিহাস (D.M.)	পঞ্চতন্ত্র (S.R.)	টানা পোড়েন (B.K.)			

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DISTRIBUTION OF SYLLABUS OF ODD SEMESTERS

Department of Botany

SYLLABUS DISTRIBUTION OF SEMESTER I (HONOURS)

Name of the Teachers	Theory (Units)	Practical (Units)
Dr. Arghya Ghosh	CC2 (Biomolecules and cell biology) - 1,2,3	CC2 (Biomolecules and cell biology) -1,2,3
Dr. Bodruddoza Arifin	GE1 (Biodiversity) - 2,3	GE1 (Biodiversity)- 7-12
Mr. Arabinda Samanta	CC1 (Phycology and Microbiology)- 1,2,3	CC1 (Phycology and Microbiology)- 1,2,3
Mr. Momezul Haque	CC2 (Biomolecules and cell biology) - 6,7	CC2 (Biomolecules and cell biology) - 6, 7
Mr. Saurav Paul	CC2 (Biomolecules and cell biology) -4,5 GE1 (Biodiversity)- 1,7	CC2 (Biomolecules and cell biology) - 4,5 GE1 (Biodiversity)- 1-6
Dr. Sudip Kumar Das	CC1 (Phycology and Microbiology)- 4,5,6,7	CC1 (Phycology and Microbiology)- 4,5
Mrs. Daliya Mahata	GE1 (Biodiversity)- 4,5,6	GE1 (Biodiversity) - 13-17

SYLLABUS DISTRIBUTION OF SEMESTER I (GENERAL)

Name of the Teachers	Theory (Units)	Practical (Units)
Dr. Arghya Ghosh		
Dr. Bodruddoza Arifin	DSC -1A (Biodiversity)- 2,3	DSC -1A (Biodiversity) - 7-12
Mr. Arabinda Samanta		
Mr. Momezul Haque		
Mr. Saurav Paul	DSC -1A (Biodiversity) - 1,7	DSC -1A (Biodiversity) – 1-6
Dr. Sudip Kumar Das		
Mrs. Daliya Mahata	DSC -1A (Biodiversity) - 4,5,6	DSC -1A (Biodiversity) – 13-16

SYLLABUS DISTRIBUTION OF SEMESTER III (HONOURS)

Name of the Teachers	Theory (Units)	Practical (Units)
Dr. Arghya Ghosh	CC5 (Anatomy of Angiosperms)- 1,2,3 + GE (Economic Botany and Plant Biotechnology)- 8,9,10	CC5 (Anatomy of Angiosperms)- 1-6 + GE (Economic Botany and Plant Biotechnology)- 2,3,4
Dr. Bodruddoza Arifin	CC6 (Economic Botany) - 8-11.	CC6 (Economic Botany) - 8-12.
Mr. Arabinda Samanta	CC7 (Genetics) - 1-3	CC7 (Genetics) - 1-6
Mr. Momezul Haque	CC5 (Anatomy of Angiosperms)- 4,5,6	CC5 (Anatomy of Angiosperms)- 7-12
Mr. Saurav Paul	CC7 (Genetics) - 4-7	CC7 (Genetics) - 7-11
Dr. Sudip Kumar Das	SEC 1 (Floriculture)- 1-7	
Mrs. Daliya Mahata	CC6 (Economic Botany) - 1-7 + GE (Economic Botany and Plant Biotechnology)- 1-7	CC6 (Economic Botany) - 1-7 + + GE (Economic Botany and Plant Biotechnology)- 1

SYLLABUS DISTRIBUTION OF SEMESTER III (GENERAL)

Name of the Teachers	Theory (Units)	Practical (Units)
Dr. Arghya Ghosh		
Dr. Bodruddoza Arifin	DSC-1C- (Plant Anatomy and Embryology) - 6-8	DSC-1C- (Plant Anatomy and Embryology) - 1-4
Mr. Arabinda Samanta		
Mr. Momezul Haque	DSC-1C- (Plant Anatomy and Embryology) -1-3	DSC-1C- (Plant Anatomy and Embryology) -5-8
Mr. Saurav Paul		
Dr. Sudip Kumar Das	SEC 1 (Biofertilizers) – 1-5	
Mrs. Daliya Mahata	DSC-1C (Plant Anatomy and Embryology) - 4, 5	DSC-1C- (Plant Anatomy and Embryology) – 9-13

SYLLABUS DISTRIBUTION OF SEMESTER V (HONOURS)

Name of the Teachers	Theory (Units)	Practical (Units)
Dr. Arghya Ghosh	CC12 (Plant Physiology) - 1-4	CC12 (Plant Physiology) - 1-4
Dr. Bodruddoza Arifin	CC11 (Reproductive Biology of Angiosperms) - 5-8	CC11 (Reproductive Biology of Angiosperms) - 5-7
Mr. Arabinda Samanta	CC11 (Reproductive Biology of Angiosperms) - 1-4 DSE 2- (Plant Breeding) - 4,5	CC11 (Reproductive Biology of Angiosperms) - 1-4 DSE 2 (Plant Breeding) - 4
Mr. Momezul Haque	DSE 1 (Natural Resource Management) - 6-9	DSE 1 (Natural Resource Management) - 4,5
Mr. Saurav Paul	CC12 (Plant Physiology) - 5-7 DSE 2 (Plant Breeding) - 1-3	CC12 (Plant Physiology) - 5-8 DSE 2 (Plant Breeding) - 1-3
Dr. Sudip Kumar Das	DSE 1 (Natural Resource Management) - 1-5	DSE 1 (Natural Resource Management) - 1-3
Mrs. Daliya Mahata		

SYLLABUS DISTRIBUTION OF SEMESTER V (GENERAL)

Name of the Teachers	Theory (Units)	Practical (Units)
Dr. Arghya Ghosh		
Dr. Bodruddoza Arifin		
Mr. Arabinda Samanta	DSE1 (GEN) (Economic Botany and Biotechnology) - 8-10	DSE1 (GEN) (Economic Botany and Biotechnology) - 2-4
Mr. Momezul Haque		
Mr. Saurav Paul		
Dr. Sudip Kumar Das	SEC -3 (Ethnobotany)- 1-4	
Mrs. Daliya Mahata	DSE 1 (GEN) Economic Botany and Biotechnology- 1-7	DSE 1 (GEN) Economic Botany and Biotechnology- 1

DISTRIBUTION OF SYLLABUS OF EVEN SEMESTER

Department of Botany

SYLLABUS DISTRIBUTION OF SEMESTER II (HONOURS)

Name of the Teachers	Theory (Units)	Practical (Units)
Dr. Arghya Ghosh		
Dr. Bodruddoza Arifin	C3 (Mycology and Phytopathology)– 5-9	C3 (Mycology and Phytopathology)– 6-11
Mr. Arabinda Samanta	C4 (Archegoniate)– 1-3	C4 (Archegoniate) – 1-6
Mr. Momezul Haque	GE2(Plant Ecology and Taxonomy)- 1-6	GE2 (Plant Ecology and Taxonomy) – 1-4
Mr. Saurav Paul	C4 (Archegoniate) – 4-6	C4 (Archegoniate) – 7-14
Dr. Sudip Kumar Das	C3 (Mycology and Phytopathology) – 1-4	C3 (Mycology and Phytopathology) – 1-5
Mrs. Daliya Mahata	GE2 (Plant Ecology and Taxonomy) - 6-12	GE2 (Plant Ecology and Taxonomy) - 4-8

SYLLABUS DISTRIBUTION OF SEMESTER II (GENERAL)

Name of the Teachers	Theory (Units)	Practical (Units)
Dr. Arghya Ghosh		
Dr. Bodruddoza Arifin	DSC1B (Plant Ecology and Taxonomy) – 7-12	DSC1B (Plant Ecology and Taxonomy) – 5-7
Mr. Arabinda Samanta		
Mr. Momezul Haque	DSC1B (Plant Ecology and Taxonomy) – 1-6	DSC1B (Plant Ecology and Taxonomy) – 1-4
Mr. Saurav Paul		
Dr. Sudip Kumar Das		
Mrs. Daliya Mahata		

SYLLABUS DISTRIBUTION OF SEMESTER IV (HONOURS)

Name of the Teachers	Theory (Units)	Practical (Units)
Dr. Arghya Ghosh	C8 (Molecular Biology)– 1-7	C8 (Molecular Biology) – 1-8
Dr. Bodruddoza Arifin	C9 (Plant Ecology and Phytogeography) – 1,2,3,4	C9 (Plant Ecology and Phytogeography)– 1,2,3,4
Mr. Arabinda Samanta	C9 (Plant Ecology and Phytogeography) – 5,6,7,8,9,10	C9 (Plant Ecology and Phytogeography) – 5,6,7,8,9,10,11,12,13
Mr. Momezul Haque	GE4 (Plant Physiology and Metabolism) – 1-9	GE4 (Plant Physiology and Metabolism) – 1-8
Mr. Saurav Paul	C10 (Plant Systematics) – 4,5,6	C10 (Plant Systematics) – 1; 1.9 – 1.16,2,3
Dr. Sudip Kumar Das	SEC2 (Mushroom Culture Technology) – 1-4	
Mrs. Daliya Mahata	C10 (Plant Systematics) – 1,2,3	C10 (Plant Systematics) – 1; 1.1-1.8,2,3

SYLLABUS DISTRIBUTION OF SEMESTER IV (GENERAL)

Name of the Teachers	Theory (Units)	Practical (Units)
Dr. Arghya Ghosh		
Dr. Bodruddoza Arifin	DSC1D (Plant Physiology and Metabolism) – 5,6,7,8,9	DSC1D (Plant Physiology and Metabolism) – 5,6,7,8
Mr. Arabinda Samanta		
Mr. Momezul Haque	DSC1D (Plant Physiology and Metabolism) – 1,2,3,4	DSC1D (Plant Physiology and Metabolism) – 1,2,3,4+5(Demonstration)
Mr. Saurav Paul		
Dr. Sudip Kumar Das		
Mrs. Daliya Mahata		

SYLLABUS DISTRIBUTION OF SEMESTER VI (HONOURS)

Name of the Teachers	Theory (Units)	Practical (Units)
Dr. Arghya Ghosh	C14 (Plant Biotechnology) – 1,4,5 DSE4 (Analytical Techniques in Plant Sciences) – 6	C14 (Plant Biotechnology) – 1-5 DSE4 (Analytical Techniques in Plant Sciences)– 1-4
Dr. Bodruddoza Arifin	C13 (Plant Metabolism)– 1,2,3,7 DSE4 (Analytical Techniques in Plant Sciences) - 2	C13 (Plant Metabolism) – 1-5 DSE4 (Analytical Techniques in Plant Sciences) – 5-8
Mr. Arabinda Samanta	C14 (Plant Biotechnology) – 2,3 DSE4 (Analytical Techniques in Plant Sciences) – 3,4,7	C14 (Plant Biotechnology) – 6-9 / DSE4 (Analytical Techniques in Plant Sciences) – 9-11
Mr. Momezul Haque	DSE3 (Industrial and Environmental Microbiology) – 3,4,5 DSE4 (Analytical Techniques in Plant Sciences) - 5	
Mr. Saurav Paul	C13 (Plant Metabolism) – 4,5,6,8 DSE4 (Analytical Techniques in Plant Sciences) – 1	C13 (Plant Metabolism) – 6-9
Dr. Sudip Kumar Das	DSE3 (Industrial and Environmental Microbiology) – 6,7	
Mrs. Daliya Mahata	DSE3 (Industrial and Environmental Microbiology) – 1,2	DSE3 (Industrial and Environmental Microbiology) – 1,2

SYLLABUS DISTRIBUTION OF SEMESTER VI (GENERAL)

Name of the Teachers	Theory (Units)	Practical (Units)
Dr. Arghya Ghosh		
Dr. Bodruddoza Arifin		
Mr. Arabinda Samanta		
Mr. Momezul Haque	DSE2 (Genetics and Plant Breeding) – 1-5 SEC4 (Plant Diversity and Human Welfare) – 1,3	DSE2 (Genetics and Plant Breeding) – 1-3
Mr. Saurav Paul		
Dr. Sudip Kumar Das	SEC4 (Plant Diversity and Human Welfare) – 2,4	
Mrs. Daliya Mahata	DSE2 (Genetics and Plant Breeding) – 6-9	DSE2 (Genetics and Plant Breeding) – 4-8

Vidyasagar University

Curriculum for B.Sc. Honours in Chemistry [Choice Based Credit System]

Semester-I

Sl.No.	Name of the Subject	Nature	Code	Teaching Scheme in hour per week			Credit	Marks
				L	T	P		
C1	**C1T:** Organic Chemistry-I	Core Course-1		4	0	0	6	75
	C1P: Organic Chemistry-I Lab	Core Course1 [Practical]		0	0	4		
C2	**C2T:** Physical Chemistry-I	Core Course-2		4	0	0	6	75
	C2P: Physical Chemistry-I Lab	Core Course-2 [Practical]		0	0	4		
GE-1	GE-1	GE					4/5	75
	GE-1	GE					2/1	
AECC	English	AECC					2	50
				Total Credits = 20				

L=Lecture, T=Tutorial, P=Practical

AECC- Ability Enhancement Compulsory Course: English /Modern Indian Language .

Interdisciplinary/Generic Elective (GE) from other Department

[**Four papers are to be taken and each paper will be of 6 credits**]:

[Papers are to be taken from any of the following discipline (**GE-1 from Mathematics**)]: **Mathematics/ Physics /Computer Sc/Statistics/Geology/Electronics/ zoology/Botany/Microbiology /Physiology /Biotechnology/Nutrition**

In pursuance of the online meeting held on 02/06/2020, the distribution of teaching modules among the Faculty Members of the Department of Chemistry, Jhargram Raj College, for both UG and PG syllabi (under the CBCS pattern of Vidyasagar University) was done. Please note that, for each module/unit of a particular syllabus, the name of the corresponding teacher teaching the portion has been mentioned in red alongside the title of the module/unit. The distribution is subject to change(s) in the intermittent period depending on the availability of the teacher.

Semester-1

Core Course

CC-1 :ORGANIC CHEMISTRY-I Credits 06

(Credits: Theory-04, Practicals-02)

C1T1 : ORGANIC CHEMISTRY-I Credits 04

Theory: 60 Lectures

Basics of Organic Chemistry

Bonding and Physical Properties (25 Lectures)

Dr. Tapas Kumar Adalder (TA) & Dr. Ansuman Bej (AB)

Valence Bond Theory: concept of hybridisation, shapes of molecules, resonance (including hyperconjugation); calculation of formal charges and double bond equivalent (DBE); orbital pictures of bonding (sp^3, sp^2, sp: C-C, C-N & C-O systems and *s-cis* and *s-trans* geometry for suitable cases).

Electronic displacements: inductive effect, field effect, mesomeric effect, resonance energy; bond polarization and bond polarizability; electromeric effect; steric effect, steric inhibition of resonance.

MO theory: qualitative idea about molecular orbitals, bonding and antibonding interactions, idea about σ, σ^*, π, π^*, n – MOs; basic idea about Frontier MOs (FMO); concept of HOMO, LUMO and SOMO; interpretation of chemical reactivity in terms of FMO interactions; sketch and energy levels of π MOs of i) acyclic p orbital system (C=C, conjugated diene, triene, allyl and pentadienyl systems) ii) cyclic p orbital system (neutral systems: [4], [6]-annulenes; charged systems: 3-,4-,5-membered ring systems); Hückel's rules for aromaticity up to [10]-annulene (including mononuclear heterocyclic compounds up to 6-membered ring); concept of antiaromaticity and homoaromaticity; non-aromatic molecules; Frost diagram; elementary idea about α and β; measurement of delocalization energies in terms of β for buta-1,3-diene, cyclobutadiene, hexa-1,3,5-triene and benzene.

Physical properties: influence of hybridization on bond properties: bond dissociation energy (BDE) and bond energy; bond distances, bond angles; concept of bond angle strain (Baeyer's strain theory); melting point/boiling point and solubility of common organic compounds in terms of covalent & non-covalent intermolecular forces; polarity of molecules and dipole moments; relative stabilities of isomeric hydrocarbons in terms of heat of hydrogenation, heat of combustion and heat of formation.

General Treatment of Reaction Mechanism I (10 Lectures)

Dr. Ansuman Bej (AB)

Mechanistic classification: ionic, radical and pericyclic (definition and example);

reaction type: addition, elimination and substitution reactions (definition and example); nature of bond cleavage and bond formation: homolytic and heterolytic bond fission, homogenic and

heterogenic bond formation; curly arrow rules in representation of mechanistic steps; reagent type: electrophiles and nucleophiles (elementary idea); electrophilicity and nucleophilicity in terms of FMO approach.

Reactive intermediates: carbocations (carbenium and carbonium ions), carbanions, carbon radicals, carbenes: generation and stability, structure using orbital picture and electrophilic/nucleophilic behavior of reactive intermediates (elementary idea).

Stereochemistry I **(25 Lectures)**

Dr. Susovan Mandal (SM)

Bonding geometries of carbon compounds and representation of molecules: tetrahedral nature of carbon and concept of asymmetry; Fischer, sawhorse, flying-wedge and Newman projection formulae and their inter translations.

Concept of chirality and symmetry: symmetry elements and point groups ($C_{\infty v}$, C_{nh}, C_{nv}, C_n, $D_{\infty h}$, D_{nh}, D_{nd}, D_n, S_n (C_s, C_i); molecular chirality and centre of chirality; asymmetric and dissymmetric molecules; enantiomers and diastereomers; concept of epimers; concept of stereogenicity, chirotopicity and pseudoasymmetry; chiral centres and number of stereoisomerism: systems involving 1/2/3-chiral centre(s) (AA, AB, ABA and ABC types).

Relative and absolute configuration: D/L and *R/S* descriptors; *erythro/threo* and *meso* nomenclature of compounds; *syn/anti* nomenclatures for aldols; *E/Z* descriptors for C=C, conjugated diene, triene, C=N and N=N systems; combination of *R/S*- and *E/ Z*- isomerisms.

Optical activity of chiral compounds: optical rotation, specific rotation and molar rotation; racemic compounds, racemisation (through cationic, anionic, radical intermediates and through reversible formation of stable achiral intermediates); resolution of acids, bases and alcohols via diastereomeric salt formation; optical purity and enantiomeric excess; invertomerism of chiral trialkylamines.

Reference Books

1. Clayden, J., Greeves, N. & Warren, S. *Organic Chemistry,* Second edition, Oxford University Press, 2012.
2. Keeler, J., Wothers, P. *Chemical Structure and Reactivity – An Integrated approach*, Oxford University Press.
3. Sykes, P. *A guidebook to Mechanism in Organic Chemistry,* Pearson Education, 2003.
4. Smith, J. G. *Organic Chemistry*, Tata McGraw-Hill Publishing Company Limited.
5. Carey, F. A., Guiliano, R. M. *Organic Chemistry*, Eighth edition, McGraw Hill Education, 2012.
6. Eliel, E. L. & Wilen, S. H. *Stereochemistry of Organic Compounds*, Wiley: London, 1994.
7. Nasipuri, D. *Stereochemistry of Organic Compounds,* Wiley Eastern Limited.
8. Morrison, R. N. & Boyd, R. N. *Organic Chemistry*, Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).
9. Finar, I. L. *Organic Chemistry (Volume 1)*, Dorling Kindersley (India) Pvt. Ltd. (Pearson Education)
10. Fleming, I. *Molecular Orbitals and Organic Chemical Reactions*, Reference/Student Edition, Wiley, 2009.

11. James, J., Peach, J. M. *Stereochemistry at a Glance*, Blackwell Publishing, 2003.

12. Robinson, M. J. T., *Stereochemistry*, Oxford Chemistry Primer, Oxford University Press, 2005.

CC1P1 - CHEMISTRY LAB- I — Credits 02

Dr. Susovan Mandal (SM)

(60 Lectures)

1. Separation, based upon solubility, by using common laboratory reagents like water (cold, hot), dil. HCl, dil. NaOH, dil. $NaHCO_3$, *etc*., of components of a binary solid mixture; purification of **any one** of the separated components by crystallization and determination of its melting point. The composition of the mixture may be of the following types: Benzoic acid/*p*-Toluidine; *p*-Nitrobenzoic acid/*p*-Aminobenzoic acid; *p*-Nitrotolune/*p*-Anisidine; *etc*.

2. **Determination of boiling point** of common organic liquid compounds e.g., ethanol, cyclohexane, chloroform, ethyl methyl ketone, cyclohexanone, acetylacetone, anisole, crotonaldehyde, mesityl oxide, *etc*. [Boiling point of the chosen organic compounds should preferably be less than 160 °C]

3. **Identification of a Pure Organic Compound**

Solid compounds: oxalic acid, tartaric acid, citric acid, succinic acid, resorcinol, urea, glucose, cane sugar, benzoic acid and salicylic acid

Liquid Compounds: formic acid, acetic acid, methyl alcohol, ethyl alcohol, acetone, aniline, dimethylaniline, benzaldehyde, chloroform and nitrobenzene

Reference Books

1. Bhattacharyya, R. C, *A Manual of Practical Chemistry.*

2. Vogel, A. I. *Elementary Practical Organic Chemistry,* Part 2: *Qualitative Organic Analysis,* CBS Publishers and Distributors.

3. Mann, F.G. & Saunders, B.C. *Practical Organic Chemistry,* Pearson Education (2009).

4. Furniss, B.S., Hannaford, A.J., Smith, P.W.G., Tatchell, A.R. *Practical Organic Chemistry,5th Ed.,* Pearson (2012).

5. Dutta, S, *B. Sc. Honours Practical Chemistry*, Bharati Book Stall.

CC-2: PHYSICAL CHEMISTRY-I — Credits 06

(Credits: Theory-04, Practicals-02)

C2 T2 : PHYSICAL CHEMISTRY-I Credits 04

(Theory: 60 Lectures)

Kinetic Theory and Gaseous state Dr. Pradipta Ghosh (PG) **(20 Lectures)**

Kinetic Theory of gases: Concept of pressure and temperature; Collision of gas molecules; Collision diameter; Collision number and mean free path; Frequency of binary collisions (similar and different molecules); Wall collision and rate of effusion

Maxwell's distribution of speed and energy: Nature of distribution of velocities, Maxwell's distribution of speeds in one, two and three dimensions; Kinetic energy distribution in one, two and three dimensions, calculations of average, root mean square and most probable values in each case; Calculation of number of molecules having energy ≥ ε, Principle of equipartition of energy and its application to calculate the classical limit of molar heat capacity of gases

Real gas and virial equation: Deviation of gases from ideal behavior; compressibility factor; Boyle temperature; Andrew's and Amagat's plots; van der Waals equation and its features; its derivation and application in explaining real gas behaviour, other equations of state (Berthelot, Dietrici); Existence of critical state, Critical constants in terms of van der Waals constants; Law of corresponding states; virial equation of state; van der Waals equation expressed in virial form and significance of second virial coefficient; Intermolecular forces (Debye, Keesom and London interactions; Lennard-Jones potential - elementary idea)

Chemical Thermodynamics Dr. Nabakumar Bera (NKB) **(25 Lectures)**

Zeroth and 1st law of Thermodynamics: Intensive and extensive variables; state and path functions; isolated, closed and open systems; zeroth law of thermodynamics; Concept of heat, work, internal energy and statement of first law; enthalpy, *H*; relation between heat capacities, calculations of *q*, *w*, *U* and *H* for reversible, irreversible and free expansion of gases (ideal and van der Waals) under isothermal and adiabatic conditions; Joule's experiment and its consequence.

Thermochemistry: Standard states; Heats of reaction; enthalpy of formation of molecules and ions and enthalpy of combustion and its applications; Laws of thermochemistry; bond energy, bond dissociation energy and resonance energy from thermochemical data, Kirchhoff's equations and effect of pressure on enthalpy of reactions; Adiabatic flame temperature; explosion temperature

Second Law: Need for a Second law; statement of the second law of thermodynamics; Concept of heat reservoirs and heat engines; Carnot cycle; Physical concept of Entropy; Carnot engine and refrigerator; Kelvin – Planck and Clausius statements and equivalence of the two statements with entropic formulation; Carnot's theorem; Values of §dQ/T and Clausius inequality; Entropy change of systems and surroundings for various processes and transformations; Entropy and unavailable work; Auxiliary state functions (G and A) and their variation with T, P and V. Criteria for spontaneity and equilibrium.

Thermodynamic relations: Maxwell's relations; Gibbs- Helmholtz equation, Joule-Thomson experiment and its consequences; inversion temperature; Joule-Thomson coefficient for a van der Waals gas; General heat capacity relations

c) Chemical kinetics Dr. Nabakumar Bera (NKB) **(15 Lectures)**

Rate law, order and molecularity: Introduction of rate law, Extent of reaction; rate constants, order; Forms of rates of First, second and nth order reactions; Pseudo first order reactions (example using acid catalyzed hydrolysis of methyl acetate); Determination of order of a reaction by half-life and differential method; Opposing reactions, consecutive reactions and parallel reactions (with explanation of kinetic and thermodynamic control of products; all steps first order)

Role of T and theories of reaction rate: Temperature dependence of rate constant; Arrhenius equation, energy of activation; Rate-determining step and steady-state approximation – explanation with suitable examples; Collision theory; Lindemann theory of unimolecular reaction; outline of Transition State theory (classical treatment)

Homogeneous catalysis: Homogeneous catalysis with reference to acid-base catalysis; Primary kinetic salt effect; Enzyme catalysis; Michaelis-Menten equation, Lineweaver-Burk plot, turn-over number

Autocatalysis; periodic reactions

Reference Books:

1. Atkins, P. W. & Paula, J. de *Atkins' Physical Chemistry*, Oxford University Press
2. Castellan, G. W. *Physical Chemistry*, Narosa
3. McQuarrie, D. A. & Simons, J. D. *Physical Chemistry: A Molecular Approach*, Viva Press
4. Engel, T. & Reid, P. *Physical Chemistry*, Pearson
5. Levine, I. N. *Physical Chemistry*, Tata McGraw-Hill
6. Maron, S. & Prutton *Physical Chemistry*
7. Ball, D. W. *Physical Chemistry*, Thomson Press
8. Mortimer, R. G. *Physical Chemistry*, Elsevier
9. Laidler, K. J. *Chemical Kinetics*, Pearson
10. Glasstone, S. & Lewis, G.N. *Elements of Physical Chemistry*
11. Rakshit, P.C., *Physical Chemistry* Sarat Book House
12. Zemansky, M. W. & Dittman, R.H. *Heat and Thermodynamics*, Tata-McGraw-Hill
13. Rastogi, R. P. & Misra, R.R. *An Introduction to Chemical Thermodynamics*, Vikas
14. Clauze & Rosenberg, *Chemical Thermodynamics*

C 2P2 : CHEMISTRY LAB-II Credits 04

(60 Lectures)

Dr. Pradipta Ghosh (PG)

Experiment 1: Determination of pH of unknown solution (buffer), by color matching method

Experiment 2: Determination of heat of neutralization of a strong acid by a strong base

Experiment 3: Study of kinetics of acid-catalyzed hydrolysis of methyl acetate

Experiment 4: Study of kinetics of decomposition of H_2O_2

Experiment 5: Determination of heat of solution of oxalic acid from solubility measurement

Reference Books

1. Viswanathan, B., Raghavan, P.S. *Practical Physical Chemistry* Viva Books (2009)
2. Mendham, J., A. I. Vogel's Quantitative Chemical Analysis 6th Ed., Pearson
3. Harris, D. C. *Quantitative Chemical Analysis*. 6th Ed., Freeman (2007)
4. Palit, S.R., De, S. K. *Practical Physical Chemistry* Science Book Agency
5. *University Hand Book of Undergraduate Chemistry Experiments*, edited by Mukherjee, G. N., University of Calcutta
6. Levitt, B. P. edited *Findlay's Practical Physical Chemistry* Longman Group Ltd.
7. Gurtu, J. N., Kapoor, R., *Advanced Experimental Chemistry* S. Chand & Co. Ltd.

Generic Elective Syllabus

GE-1 [Interdisciplinary for other department]

GE-1 : ATOMIC STRUCTURE, CHEMICAL PERIODICITY, ACIDS AND BASES, REDOX REACTIONS, GENERAL ORGANIC CHEMISTRY & ALIPHATIC HYDROCARBONS. Credits 06

GE1 T1 : ATOMIC STRUCTURE, CHEMICAL PERIODICITY, ACIDS AND BASES, REDOX REACTIONS, GENERAL ORGANIC CHEMISTRY & ALIPHATIC HYDROCARBONS. Credits 04
Theory: 60 Lectures

Section A: Inorganic Chemistry-I (30 Lectures)

Atomic Structure Dr. Tarun Mistri (TM) **(10 Lectures)**

Bohr's theory for hydrogen atom (simple mathematical treatment), atomic spectra of hydrogen and Bohr's model, Sommerfeld's model, quantum numbers and their significance, Pauli's exclusion principle, Hund's rule, electronic configuration of many-electron atoms, *Aufbau* principle and its limitations.

Chemical Periodicity Smt. Sanchayita Adikari (SA) **(05 Lectures)**
Classification of elements on the basis of electronic configuration: general characteristics of s-, p-, d- and f-block elements. Positions of hydrogen and noble gases. Atomic and ionic radii, ionization potential, electron affinity, and electronegativity; periodic and group-wise variation of above properties in respect of s- and p- block elements.

Acids and bases Smt. Sanchayita Adikari (SA) **(10 Lectures)**
Brönsted–Lowry concept, conjugate acids and bases, relative strengths of acids and bases, effects of substituent and solvent, differentiating and levelling solvents. Lewis acid-base concept, classification of Lewis acids and bases, Lux-Flood concept and solvent system concept. Hard and soft acids and bases (HSAB concept), applications of HSAB process.

Redox reactions Dr. Tarun Mistri (TM) **(05 Lectures)**
Balancing of equations by oxidation number and ion-electron method oxidimetry and reductimetry.

***Section B: Organic Chemistry-I* (30 Lectures)**

Fundamentals of Organic Chemistry Dr. Ansuman Bej (AB) **(5 Lectures)**
Electronic displacements: inductive effect, resonance and hyperconjugation; cleavage of bonds: homolytic and heterolytic; structure of organic molecules on the basis of VBT; nucleophiles electrophiles; reactive intermediates: carbocations, carbanions and free radicals.

Stereochemistry Dr. Susovan Mandal (SM) **(8 Lectures)**
Different types of isomerism; geometrical and optical isomerism; concept of chirality and optical activity (up to two carbon atoms); asymmetric carbon atom; elements of symmetry (plane and centre); interconversion of Fischer and Newman representations; enantiomerism and diastereomerism, *meso* compounds; *threo* and *erythro,* D and L, *cis* and *trans* nomenclature; CIP Rules: *R/S* (upto 2 chiral carbon atoms) and *E/Z* nomenclature.

Nucleophilic Substitution and Elimination Reactions Dr. Ansuman Bej (AB) **(5 Lectures)**

Nucleophilic substitutions: S_N1 and S_N2 reactions; eliminations: E1 and E2 reactions (elementary mechanistic aspects); Saytzeff and Hofmann eliminations; elimination *vs* substitution.

Aliphatic Hydrocarbons Dr. Prasanta Patra (PP) **(12 Lectures)**

Functional group approach for the following reactions (preparations & reactions) to be studied in context to their structures.

Alkanes: (up to 5 Carbons). *Preparation:* catalytic hydrogenation, Wurtz reaction, Kolbe's synthesis, from Grignard reagent. *Reactions:* mechanism for free radical substitution: halogenation.

Alkenes: (up to 5 Carbons). *Preparation:* elimination reactions: dehydration of alcohols and dehydrohalogenation of alkyl halides; *cis* alkenes (partial catalytic hydrogenation) and *trans* alkenes (Birch reduction). *Reactions: cis*-addition (alkaline $KMnO_4$) and *trans*-addition (bromine) with mechanism, addition of HX [Markownikoff's (with mechanism) and anti-Markownikoff's addition], hydration, ozonolysis, oxymercuration-demercuration and hydroboration-oxidation reaction.

Alkynes: (up to 5 Carbons). *Preparation:* acetylene from CaC_2 and conversion into higher alkynes; by dehalogenation of tetra halides and dehydrohalogenation of vicinal dihalides.

Reactions: formation of metal acetylides, addition of bromine and alkaline $KMnO_4$, ozonolysis and oxidation with hot alkaline $KMnO_4$.

Reference Books:

1. Lee, J.D. *Concise Inorganic Chemistry* ELBS, 1991.
2. Cotton, F.A., Wilkinson, G. & Gaus, P.L. *Basic Inorganic Chemistry*, 3rd ed., Wiley.
3. Douglas, B.E., McDaniel, D.H. & Alexander, J.J. *Concepts and Models in Inorganic Chemistry*, John Wiley & Sons.
4. Huheey, J.E., Keiter, E.A., Keiter, R.L. & Medhi, O.K. *Inorganic Chemistry: Principles of Structure and Reactivity*, Pearson Education India, 2006.
5. Sethi, A. *Conceptual Organic Chemistry;* New Age International Publisher.
6. Parmar, V. S. *A Text Book of Organic Chemistry*, S. Chand & Sons.
7. Madan, R. L. *Organic Chemistry*, S. Chand & Sons.
8. Wade, L. G., Singh, M. S., *Organic Chemistry.*
9. Finar, I. L. *Organic Chemistry* (*Volume 1*), Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).
10. Morrison, R. T. & Boyd, R. N. *Organic Chemistry*, Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).
11. Eliel, E. L. & Wilen, S. H. *Stereochemistry of Organic Compounds*, Wiley: London, 1994.
12. Sen Gupta, Subrata. *Basic Stereochemistry of Organic molecules.*
13. Kalsi, P. S. *Stereochemistry Conformation and Mechanism*, Eighth edition, New Age International, 2014.
14. Bahl, A. & Bahl, B.S. *Advanced Organic Chemistry,* S. Chand, 2010.

GE1 P1: LAB: ATOMIC STRUCTURE, CHEMICAL PERIODICITY, ACIDS AND BASES, REDOX REACTIONS, GENERAL ORGANIC CHEMISTRY & ALIPHATIC HYDROCARBONS

Credits 02

60 Lectures

Section A: Inorganic Chemistry –LAB **(30 Lectures)**

Dr. Tarun Mistri (TM) & Smt. Sanchayita Adikari (SA)

1. Estimation of sodium carbonate and sodium hydrogen carbonate present in a mixture.
2. Estimation of oxalic acid by titrating it with $KMnO_4$.
3. Estimation of water of crystallization in Mohr's salt by titrating with $KMnO_4$.
4. Estimation of Fe (II) ions by titrating it with $K_2Cr_2O_7$ using internal indicator.
5. Estimation of Cu (II) ions iodometrically using $Na_2S_2O_3$.

Section B: Organic Chemistry- LAB **(30 Lectures)**

Dr. Susovan Mandal (SM)

Qualitative Analysis of Single Solid Organic Compound(s)

Experiment A: Detection of special elements (N, Cl, and S) in organic compounds.

Experiment B: Solubility and Classification (solvents: H2O, dil. HCl, dil. NaOH)

Experiment C: Detection of functional groups: Aromatic-NO2, Aromatic -NH2, - COOH, carbonyl (no distinction of –CHO and >C=O needed), -OH (phenolic) in solid organic compounds.

Experiments A - C with unknown (at least 6) solid samples containing not more than two of the above type of functional groups should be done.

Reference Books:

1. *University Hand Book of Undergraduate Chemistry Experiments*, edited by Mukherjee, G. N., University of Calcutta, 2003.
2. Das, S. C., Chakraborty, S. B., *Practical Chemistry.*
3. Mukherjee, K. S. *Text book on Practical Chemistry*, New Oriental Book Agency.
4. Ghosal, Mahapatra & Nad, *An Advanced course in practical Chemistry,* New Central Book Agency.
5. Vogel, A. I. *Elementary Practical Organic Chemistry,* Part 2: *Qualitative Organic Analysis,* CBS Publishers and Distributors.
6. Vogel, A.I., Tatchell, A.R., Furnis, B.S., Hannaford, A.J. & Smith, P.W.G., *Textbook of Practical Organic Chemistry*, Prentice-Hall, 5th edition, 1996.
7. Mann, F.G. & Saunders, B.C. *Practical Organic Chemistry* Orient-Longman, 1960.

Vidyasagar University

Curriculum for B.Sc. Honours in Chemistry [Choice Based Credit System]

Semester-II

Sl. No.	Name of the Subject	Nature	Code	Teaching Scheme in hour per week			Credit	Marks
				L	T	P		
C3	**C3T:** Inorganic Chemistry-I	Core Course-3		4	0	0	6	75
	C3P: Inorganic Chemistry-I Lab	Core Course-3 [Practical]		0	0	4		
C4	**C4T:** Organic Chemistry-II	Core Course-4		4	0	0	6	75
	C4P: Organic Chemistry-II Lab	Core Course-4 [Practical]		0	0	4		
GE-2	GE-2	GE					4/5	75
	GE-2	GE					2/1	
AEC C-2	Environmental Studies	AECC					4	100
				Total Credits = 22				

L=Lecture, T=Tutorial, P=Practical

AECC- Ability Enhancement Compulsory Course: Environmental Studies.
Interdisciplinary/Generic Elective (GE) from other Department
[**Four papers are to be taken and each paper will be of 6 credits**]:
[Papers are to be taken from any of the following discipline (**GE-2 from Mathematics**)]:
Mathematics/Physics /Computer Sc/Statistics/Geology/Electronics/ zoology/Botany /Microbiology /Physiology/Biotechnology/Nutrition

Semester-II
Core Course

Core-3

CC-3: INORGANIC CHEMISTRY-I **Credits 06**
(Credits: Theory-04, Practicals-02)

C3T: INORGANIC CHEMISTRY-I **Credits 04**
Theory: 60 Lectures

Extra nuclear Structure of atom Dr. Nabakumar Bera (NKB) **(18 Lectures)**

Bohr's theory, its limitations and atomic spectrum of hydrogen atom; Sommerfeld's Theory. Wave mechanics: de Broglie equation, Heisenberg's Uncertainty Principle and its significance, Schrödinger's wave equation, significance of ψ and ψ^2. Quantum numbers and their significance. Radial and angular wave functions for hydrogen atom. Radial and angular distribution curves. Shapes of *s*, *p*, *d* and *f* orbitals. Pauli's Exclusion Principle, Hund's rules and multiplicity, Exchange energy, Aufbau principle and its limitations, Ground state Term symbols of atoms and ions for atomic number upto 30.

Chemical periodicity Dr. Tarun Mistri (TM) **(8 Lectures)**

Modern IUPAC Periodic table, Effective nuclear charge, screening effects and penetration, Slater's rules, atomic radii, ionic radii (Pauling's univalent), covalent radii, lanthanide contraction. Ionization potential, electron affinity and electronegativity (Pauling's, Mulliken's and Allred-Rochow's scales) and factors influencing these properties, group electronegativities. Group trends and periodic trends in these properties in respect of s-, p- and d-block elements. Secondary periodicity, Relativistic Effect, Inert pair effect.

Acid-Base reactions Dr. Tarun Mistri (TM) **(16 Lectures)**

Acid-Base concept: Arrhenius concept, theory of solvent system (in H_2O, NH_3, SO_2 and HF), Bronsted-Lowry's concept, relative strength of acids, Pauling's rules. Lux-Flood concept, Lewis concept, group characteristics of Lewis acids, solvent levelling and differentiating effects. Thermodynamic acidity parameters, Drago-Wayland equation. Superacids, Gas phase acidity and proton affinity; HSAB principle. Acid-base equilibria in aqueous solution (Proton transfer equilibria in water), pH, buffer. Acid-base neutralisation curves; indicator, choice of indicators.

Redox Reactions and precipitation reactions Smt. Sanchayita Adikari (SA) **(18 Lectures)**
Ion-electron method of balancing equation of redox reaction. Elementary idea on standard redox potentials with sign conventions, Nernst equation (without derivation). Influence of complex formation, precipitation and change of pH on redox potentials; formal potential. Feasibility of a redox titration, redox potential at the equivalence point, redox indicators. Redox potential diagram (Latimer and Frost diagrams) of common elements and their applications. Disproportionation and comproportionation reactions (typical examples)

Solubility product principle, common ion effect and their applications to the precipitation and separation of common metallic ions as hydroxides, sulfides, phosphates, carbonates, sulfates and halides.

Reference Books

1. Lee, J. D. *Concise Inorganic Chemistry*,5th Ed., Wiley India Pvt. Ltd., 2008.
2. Douglas, B.E. and McDaniel, D.H. *Concepts & Models of Inorganic Chemistry* Oxford, 1970.
3. Day, M.C. and Selbin, J. *Theoretical Inorganic Chemistry*, ACS Publications, 1962.
4. Atkin, P. *Shriver & Atkins' Inorganic Chemistry*, 5th Ed., Oxford University Press (2010).
5. Cotton, F.A., Wilkinson, G. and Gaus, P.L., *Basic Inorganic Chemistry 3rd Ed.;* Wiley India.
6. Sharpe, A.G., *Inorganic Chemistry*, 4th Indian Reprint (Pearson Education) 2005.
7. Huheey, J. E.; Keiter, E.A. & Keiter, R.L. *Inorganic Chemistry, Principles of Structure and Reactivity 4th Ed.*, Harper Collins 1993, Pearson,2006.
8. Atkins, P.W. & Paula, J. *Physical Chemistry*, Oxford Press, 2006.
9. Mingos, D.M.P., *Essential trends in inorganic chemistry*. Oxford University Press (1998).
10. Winter, M. J., The Orbitron, http://winter.group.shef.ac.uk/orbitron/ (2002). An illustrated gallery of atomic and molecular orbitals.
11. Burgess, J., *Ions in solution: basic principles of chemical interactions.* Ellis Horwood (1999).

C3P: CHEMISTRY (LAB) Credits 02

Dr. Tarun Mistri (TM) & Smt. Sanchayita Adikari (SA)

60 Lectures

Acid and Base Titrations:

1. Estimation of carbonate and hydroxide present together in mixture
2. Estimation of carbonate and bicarbonate present together in a mixture.
3. Estimation of free alkali present in different soaps/detergents.

Oxidation-Reduction Titrimetric

1. Estimation of Fe(II) using standardized $KMnO_4$ solution
2. Estimation of oxalic acid and sodium oxalate in a given mixture
3. Estimation of Fe(II) and Fe(III) in a given mixture using $K_2Cr_2O_7$ solution.
4. Estimation of Fe(III) and Mn(II) in a mixture using standardized $KMnO_4$ solution
5. Estimation of Fe(III) and Cu(II) in a mixture using $K_2Cr_2O_7$.
6. Estimation of Fe(III) and Cr(III) in a mixture using $K_2Cr_2O_7$.

Reference Books

Mendham, J., *A. I. Vogel's Quantitative Chemical Analysis* 6th Ed., Pearson, 2009.

Core-4

CC-4: ORGANIC CHEMISTRY-II **Credits 06**

(Credits: Theory-04, Practicals-02)

C4T ORGANIC CHEMISTRY-II **Credits 02**
Theory: 60 Lectures

Stereochemistry II Dr. Susovan Mandal (SM) **(20 Lectures)**

Chirality arising out of stereoaxis: stereoisomerism of substituted cumulenes with even and odd number of double bonds; chiral axis in allenes, spiro compounds, alkylidenecycloalkanes and biphenyls; related configurational descriptors (R_a/S_a and *P/M*); atropisomerism; racemisation of chiral biphenyls; *buttressing* effect.

Concept of prostereoisomerism: prostereogenic centre; concept of (*pro*)^n-*chirality*: topicity of ligands and faces (elementary idea); *pro-R/pro-S*, *pro-E/pro-Z* and *Re/Si* descriptors; *pro-r* and *pro-s* descriptors of ligands on propseudoasymmetric centre.

Conformation: conformational nomenclature: eclipsed, staggered, *gauche*, *syn* and *anti*; dihedral angle, torsion angle; Klyne-Prelog terminology; *P/M* descriptors; energy barrier of rotation, concept of torsional and steric strains; relative stability of conformers on the basis of steric effect, dipole-dipole interaction and H-bonding; *butane gauche* interaction; conformational analysis of ethane, propane, *n*-butane, 2-methylbutane and 2,3-dimethylbutane; haloalkane, 1,2-dihaloalkanes and 1,2-diols (up to four carbons); 1,2-halohydrin; conformation of conjugated systems (*s-cis* and *s-trans*).

General Treatment of Reaction Mechanism II **(22 Lectures)**
Dr. Dilip Rout (DR), Dr. Ansuman Bej (AB) & Dr. Tapas Kumar Adalder (TA)
Reaction thermodynamics: free energy and equilibrium, enthalpy and entropy factor, calculation of enthalpy change via BDE, intermolecular & intramolecular reactions. DR

Concept of organic acids and bases: effect of structure, substituent and solvent on acidity and basicity; proton sponge; gas-phase acidity and basicity; comparison between nucleophlicity and basicity; HSAB principle; application of thermodynamic principles in acid-base equilibria. AB

Tautomerism: prototropy (keto-enol, nitro - *aci*-nitro, nitroso-oximino, diazo-amino and enamine-imine systems); valence tautomerism and ring-chain tautomerism; composition of the equilibrium in different systems (simple carbonyl; 1,2- and 1,3-dicarbonyl systems, phenols and related systems), factors affecting keto-enol tautomerism; application of thermodynamic principles in tautomeric equilibria. TA

Reaction kinetics: rate constant and free energy of activation; concept of order and molecularity; free energy profiles for one-step, two-step and three-step reactions; catalyzed reactions: electrophilic and nucleophilic catalysis; kinetic control and thermodynamic control of reactions; isotope effect: primary and secondary kinetic isotopic effect (k_H /k_D); principle of microscopic reversibility; Hammond's postulate. DR

Substitution and Elimination Reactions **(18 Lectures)**

Dr. Ansuman Bej (AB)

Free-radical substitution reaction: halogentaion of alkanes, mechanism (with evidence) and stereochemical features; reactivity-selectivity principle in the light of Hammond's postulate. *Nucleophilic substitution reactions:* substitution at sp^3 centre: mechanisms (with evidence), relative rates & stereochemical features: S_N1, S_N2, S_N2', S_N1' (allylic rearrangement) and S_Ni; effects of solvent, substrate structure, leaving group and nucleophiles (including ambident nucleophiles, cyanide & nitrite); substitutions involving NGP; role of crown ethers and phase transfer catalysts; [systems: alkyl halides, allyl halides, benzyl halides, alcohols, ethers, epoxides].

Elimination reactions: E1, E2, E1cB and Ei (pyrolytic *syn* eliminations); formation of alkenes and alkynes; mechanisms (with evidence), reactivity, regioselectivity (Saytzeff/Hofmann) and stereoselectivity; comparison between substitution and elimination; importance of Bredt's rule relating to the formation of C=C.

Reference Books

1. Clayden, J., Greeves, N., Warren, S. *Organic Chemistry*, Second edition, Oxford University Press 2012.
2. Sykes, P. *A guidebook to Mechanism in Organic Chemistry*, Pearson Education, 2003.
3. Smith, J. G. *Organic Chemistry*, Tata McGraw-Hill Publishing Company Limited.
4. Carey, F. A. & Guiliano, R. M. *Organic Chemistry*, Eighth edition, McGraw Hill Education, 2012.
5. Loudon, G. M. *Organic Chemistry*, Fourth edition, Oxford University Press, 2008.
6. Eliel, E. L. & Wilen, S. H. *Stereochemistry of Organic Compounds*, Wiley: London, 1994.
7. Nasipuri, D. *Stereochemistry of Organic Compounds*, Wiley Eastern Limited.
8. Morrison, R. N. & Boyd, R. N. *Organic Chemistry*, Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).
9. Finar, I. L. *Organic Chemistry (Volume 1)* Pearson Education.
10. Graham Solomons, T.W., Fryhle, C. B. *Organic Chemistry*, John Wiley & Sons, Inc.
11. James, J., Peach, J. M. *Stereochemistry at a Glance*, Blackwell Publishing, 2003.
12. Robinson, M. J. T., *Stereochemistry*, Oxford Chemistry Primer, Oxford University Press, 2005.
13. Maskill, H., *Mechanisms of Organic Reactions*, Oxford Chemistry Primer, Oxford University Press.

C4P: CHEMISTRY (LAB) **Credits 02**

Dr. Susovan Mandal (SM) & Dr. Tapas Kumar Adalder (TA)

(60 Lectures)

Organic Preparations

A. The following reactions are to be performed, noting the yield of the crude product:

1. Nitration of aromatic compounds
2. Condensation reactions
3. Hydrolysis of amides/imides/esters
4. Acetylation of phenols/aromatic amines
5. Benzoylation of phenols/aromatic amines
6. Side chain oxidation of aromatic compounds
7. Diazo coupling reactions of aromatic amines
8. Bromination of anilides using green approach (Bromate-Bromide method)
9. Redox reaction including solid-phase method
10. Green 'multi-component-coupling' reaction
11. Selective reduction of *m*-dinitrobenzene to *m*-nitroaniline

Students must also calculate percentage yield, based upon isolated yield (crude) and theoretical yield.

B. Purification of the crude product is to be made by crystallisation from water/alcohol, crystallization after charcoal treatment, or sublimation, whichever is applicable.

C. Melting point of the purified product is to be noted.

Reference Books

1. Vogel, A. I. *Elementary Practical Organic Chemistry*, Part 1: *Small scale Preparations,* CBS Publishers and Distributors.
2. *University Hand Book of Undergraduate Chemistry Experiments,* edited by Mukherjee, G. N. University of Calcutta, 2003.
3. Mann, F.G. & Saunders, B.C. *Practical Organic Chemistry,* Pearson Education (2009).
4. Furniss, B.S., Hannaford, A.J., Smith, P.W.G. & Tatchell, A.R. *Practical Organic Chemistry, 5th Ed.* Pearson (2012).
5. Ahluwalia, V.K. & Aggarwal, R. *Comprehensive Practical Organic Chemistry: Preparation and Quantitative Analysis,* University Press (2000).
6. *Practical Workbook Chemistry (Honours), UGBS, Chemistry,* University of Calcutta, 2015.

Generic Elective Syllabus

GE-2 [Interdisciplinary for other department]

GE-2 : STATES OF MATTER & CHEMICAL KINETICS, CHEMICAL BONDING & MOLECULAR STRUCTUR, p-BLOCK ELEMENTS Credits 06

(Credits: Theory-04, Practicals-02)

GE2 T : STATES OF MATTER & CHEMICAL KINETICS, CHEMICAL BONDING & MOLECULAR STRUCTUR, p-BLOCK ELEMENTS Credits 04
Theory: 60 Lectures

Section A: Physical Chemistry-I **(30 Lectures)**

Kinetic Theory of Gases and Real gases Dr. Nabakumar Bera (NKB) **(10 Lectures)**

Concept of pressure and temperature; Collision of gas molecules; Collision diameter; Collision number and mean free path; Frequency of binary collisions (similar and different molecules); Rate of effusion

Nature of distribution of velocities, Maxwell's distribution of speed and kinetic energy; Average velocity, root mean square velocity and most probable velocity; Principle of equipartition of energy and its application to calculate the classical limit of molar heat capacity of gases

Deviation of gases from ideal behavior; compressibility factor; Boyle temperature; Andrew's and Amagat's plots; van der Waals equation and its features; its derivation and application in explaining real gas behaviour; Existence of critical state, Critical constants in terms of van der Waals constants; Law of corresponding states

Viscosity of gases and effect of temperature and pressure on coefficient of viscosity (qualitative treatment only)

Liquids Dr. Nabakumar Bera (NKB) **(06 Lectures)**

Definition of Surface tension, its dimension and principle of its determination using stalagmometer; Viscosity of a liquid and principle of determination of coefficient of viscosity using Ostwald viscometer; Effect of temperature on surface tension and coefficient of viscosity of a liquid (qualitative treatment only)

Solids Dr. Nabakumar Bera (NKB) **(06 Lectures)**

Forms of solids, crystal systems, unit cells, Bravais lattice types, Symmetry elements; Laws of Crystallography - Law of constancy of interfacial angles, Law of rational indices; Miller indices of different planes and interplanar distance, Bragg's law; Structures of NaCl, KCl and CsCl (qualitative treatment only); Defects in crystals; Glasses and liquid crystals.

Chemical Kinetics Dr. Nabakumar Bera (NKB) **(08 Lectures)**

Introduction of rate law, Order and molecularity; Extent of reaction; rate constants; Rates of First, second and nth order reactions and their Differential and integrated forms (with derivation); Pseudo first order reactions; Determination of order of a reaction by half-life and differential method; Opposing reactions, consecutive reactions and parallel reactions Temperature dependence of rate constant; Arrhenius equation, energy of activation; Collision

theory; Lindemann theory of unimolecular reaction; outline of Transition State theory (classical treatment)

Reference Books:

1. Barrow, G.M. *Physical Chemistry* Tata McGraw- Hill (2007).
2. Castellan, G.W. *Physical Chemistry* 4th Ed. Narosa (2004).
3. Kotz, J.C., Treichel, P.M. & Townsend, J.R. *General Chemistry* Cengage Learning India Pvt. Ltd., New Delhi (2009).
4. Mahan, B.H. *University Chemistry* 3rd Ed. Narosa (1998).
5. Petrucci, R.H. *General Chemistry* 5th Ed. Macmillan Publishing Co.: New York (1985).
6. Chugh, K.L., Agnish, S.L. *A Text Book of Physical Chemistry* Kalyani Publishers
7. Bahl, B.S., Bahl, A., Tuli, G.D., *Essentials of Physical Chemistry* S. Chand & Co.ltd.
8. Palit, S. R., *Elementary Physical Chemistry* Book Syndicate Pvt. Ltd.
9. Mandal, A. K. *Degree Physical and General Chemistry* Sarat Book House
10. Pahari, S., *Physical Chemistry* New Central Book Agency
11. Pahari, S., Pahari, D., *Problems in Physical Chemistry* New Central Book Agency

Section B: Inorganic Chemistry-II **(30 Lectures)**

Chemical Bonding and Molecular Structure Dr. Tarun Mistri (TM) **(16 Lectures)**

Ionic Bonding: General characteristics of ionic bonding. Energy considerations in ionic bonding, lattice energy and solvation energy and their importance in the context of stability and solubility of ionic compounds. Statement of Born-Landé equation for calculation of lattice energy, Born-Haber cycle and its applications, polarizing power and polarizability. Fajan's rules, ionic character in covalent compounds, bond moment, dipole moment and percentage ionic character.

Covalent bonding: VB Approach: Shapes of some inorganic molecules and ions on the basis of VSEPR and hybridization with suitable examples of linear, trigonal planar, square planar, tetrahedral, trigonal bipyramidal and octahedral arrangements.

Concept of resonance and resonating structures in various inorganic and organic compounds. MO Approach: Rules for the LCAO method, bonding and antibonding MOs and their characteristics for *s-s*, *s-p* and *p-p* combinations of atomic orbitals, nonbonding combination of orbitals, MO treatment of homonuclear diatomic molecules of 1st and 2nd periods. (including idea of *s- p* mixing) and heteronuclear diatomic molecules such as CO, NO and NO+. Comparison of VB and MO approaches.

Comparative study of p-block elements: Smt. Sanchayita Adikari (SA) **(14 Lectures)**

Group trends in electronic configuration, modification of pure elements, common oxidation states, inert pair effect, and their important compounds in respect of the following groups of elements:

i) B-Al-Ga-In-Tl
ii) C-Si-Ge-Sn-Pb
iii) N-P-As-Sb-Bi
iv) O-S-Se-Te
v) F-Cl-Br-I

Reference Books:

1. Cotton, F.A. & Wilkinson, G. *Basic Inorganic Chemistry*, Wiley.
2. Shriver, D.F. & Atkins, P.W. *Inorganic Chemistry*, Oxford University Press.
3. Wulfsberg, G. *Inorganic Chemistry*, Viva Books Pvt. Ltd.
4. Rodgers, G.E. *Inorganic & Solid State Chemistry*, Cengage Learning India Ltd., 2008.

GE2 P-LAB: STATES OF MATTER & CHEMICAL KINETICS, CHEMICAL BONDING & MOLECULAR STRUCTUR, p-BLOCK ELEMENTS

(60 Lectures) **Credits 02**

Section A: Physical Chemistry-LAB **(15x2=30 Lectures)**

(Minimum **five** experiments to complete)

(I) Surface tension measurement (use of organic solvents excluded) Dr. Pradipta Ghosh (PG)

a) Determination of the surface tension of a liquid or a dilute solution using a Stalagmometer
b) Study of the variation of surface tension of a detergent solution with concentration

(II) Viscosity measurement (use of organic solvents excluded) Dr. Pradipta Ghosh (PG)

a) Determination of the relative and absolute viscosity of a liquid or dilute solution using an Ostwald's viscometer
b) Study of the variation of viscosity of an aqueous solution with concentration of solute

(III) Study the kinetics of the following reactions Dr. Nabakumar Bera (NKB)

a) Initial rate method: Iodide-persulphate reaction
b) Integrated rate method:
    (i) Acid hydrolysis of methyl acetate with hydrochloric acid
    (ii) Compare the strengths of HCl and H2SO4 by studying kinetics of hydrolysis of methyl acetate

Reference Books:

1. *University Hand Book of Undergraduate Chemistry Experiments*, edited by Mukherjee, G. N., University of Calcutta, 2003.
2. Palit, S.R., *Practical Physical Chemistry* Science Book Agency
3. Mukherjee, N.G., *Selected Experiments in Physical Chemistry* J. N. Ghose & Sons
4. Dutta, S.K., *Physical Chemistry Experiments* Bharati Book Stall

Section B: Inorganic Chemistry-LAB **(30 Lectures)**

Dr. Tarun Mistri (TM) & Smt. Sanchayita Adikari (SA)

Qualitative semimicro analysis of mixtures containing three radicals. Emphasis should be given to the understanding of the chemistry of different reactions.

Acid Radicals: Cl-, Br-, I-, NO2-, NO3-, S2-, SO42-, PO43-, BO33-, H3BO3.

Basic Radicals: Na+, K+, Ca2+, Sr2+, Ba2+, Cr3+, Mn2+, Fe3+, Ni2+, Cu2+, NH4+.

Reference Books:

1. Svehla, G. *Vogel's Qualitative Inorganic Analysis*, Pearson Education, 2012.
2. Khosla, B. D.; Garg, V. C. & Gulati, A. *Senior Practical Physical Chemistry*, R. Chand & Co.: New Delhi (2011).

Vidyasagar University

Curriculum for B.Sc (Honours) in Chemistry

[Choice Based Credit System]

Semester-III

Course	Course Code	Name of the Subjects	Course Type/ Nature	Teaching Scheme in hour per week			Credit	Marks
				L	T	P		
CC-5		**C5T:** Physical Chemistry-II	Core Course - 5	4	0	0	6	75
		C5P: Physical Chemistry-II		0	0	4		
CC-6		**C6T:** Inorganic Chemistry-II	Core Course - 6	4	0	0	6	75
		C6P: Inorganic Chemistry-II		0	0	4		
CC-7		**C7T:** Organic Chemistry-III	Core Course - 7	4	0	0	6	75
		C7P: Organic Chemistry-III		0	0	4		
GE-3		**TBD**	Generic Elective -3				6	75
SEC-1		**SEC1T:** Analytical Clinical Biochemistry SEC1P: Analytical Clinical Biochemistry **Or** **SEC1T:**Pharmaceutical Chemistry **SEC1P:**Pharmaceutical Chemistry	Skill Enhancement Course-1	1	0	2	2	50
Semester Total							**26**	**350**

L=Lecture, **T=** Tutorial, **P=**Practical, **CC =** Core Course, **GE**= Generic Elective, **SEC** = Skill Enhancement Course, **TBD =** to be decided

Generic Elective (GE) (Interdisciplinary) from other Department [**Four papers are to be taken and each paper will be of 6 credits**]:
Papers are to be taken from any of the following discipline: **Mathematics/Physics /Computer Sc/Statistics/Geology/Electronics/zoology/Botany /Microbiology /Physiology/Biotechnology/Nutrition**

Modalities of selection of Generic Electives (GE): A student shall have to choose **04** Generic Elective (GE1 to GE4) strictly from **02** subjects / disciplines of choice taking exactly

02 courses from each subjects of disciplines. Such a student shall have to study the curriculum of Generic Elective (GE) of a subject or discipline specified for the relevant semester.

Semester-III
Core Course (CC)

CC-5: Physical Chemistry-II — Credits 06

C5T: Physical Chemistry-II — Credits 04

Theory: 60 Lectures

a) Transport processes (15 Lectures)
Dr. Nabakumar Bera (NKB) & Dr. Pradipta Ghosh (PG)

Fick's law: Flux, force, phenomenological coefficients & their inter-relationship (general form), different examples of transport properties NKB

Viscosity: General features of fluid flow (streamline flow and turbulent flow); Newton's equation, viscosity coefficient; Poiseuille's equation; principle of determination of viscosity coefficient of liquids by falling sphere method; Temperature variation of viscosity of liquids and comparison with that of gases NKB

Conductance and transport number: Ion conductance; Conductance and measurement of conductance, cell constant, specific conductance and molar conductance; Variation of specific and equivalent conductance with dilution for strong and weak electrolytes; Kohlrausch's law of independent migration of ions; Equivalent and molar conductance at infinite dilution and their determination for strong and weak electrolytes; Debye –Huckel theory of Ion atmosphere (qualitative)-asymmetric effect, relaxation effect and electrophoretic effect; Ostwald's dilution law; Ionic mobility; Application of conductance measurement (determination of solubility product and ionic product of water); Conductometric titrations
Transport number, Principles of Hittorf's and Moving-boundary method; Wien effect, Debye-Falkenhagen effect, Walden's rule PG

b) Applications of Thermodynamics – I Dr. Pradipta Ghosh (PG) **(25 Lectures)**

Partial properties and Chemical potential: Chemical potential and activity, partial molar quantities, relation between Chemical potential and Gibb's free energy and other thermodynamic state functions; variation of Chemical potential (μ) with temperature and pressure; Gibbs-Duhem equation; fugacity and fugacity coefficient; Variation of thermodynamic functions for systems with variable composition; Equations of states for these systems, Change in G, S H and V during mixing for binary solutions

Chemical Equilibrium: Thermodynamic conditions for equilibrium, degree of advancement; van't Hoff's reaction isotherm (deduction from chemical potential); Variation of free energy with degree of advancement; Equilibrium constant and standard Gibbs free energy change; Definitions of K_P, K_C and K_X; van't Hoff's reaction isobar and isochore from different standard states; Shifting of equilibrium due to change in external parameters e.g. temperature

and pressure; variation of equilibrium constant with addition to inert gas; Le Chatelier's principle and its derivation

Nernst's distribution law; Application- (finding out K_{eq} using Nernst dist law for $KI+I_2 = KI_3$ and dimerization of benzene

Chemical potential and other properties of ideal substances- pure and mixtures: a) Pure ideal gas-its Chemical potential and other thermodynamic functions and their changes during a change of; Thermodynamic parameters of mixing; Chemical potential of an ideal gas in an ideal gas mixture; Concept of standard states and choice of standard states of ideal gases

b) Condensed Phase – Chemical potential of pure solid and pure liquids, Ideal solution – Definition, Raoult's law; Mixing properties of ideal solutions, chemical potential of a component in an ideal solution; Choice of standard states of solids and liquids

c) Foundation of Quantum Mechanics Dr. Nabakumar Bera (NKB) **(20 Lectures)**

Beginning of Quantum Mechanics: Wave-particle duality, light as particles: photoelectric and Compton effects; electrons as waves and the de Broglie hypothesis; Uncertainty relations (without proof)

Wave function: Schrodinger time-independent equation; nature of the equation, acceptability conditions imposed on the wave functions and probability interpretations of wave function

Concept of Operators: Elementary concepts of operators, eigenfunctions and eigenvalues; Linear operators; Commutation of operators, commutator and uncertainty relation; Expectation value; Hermitian operator; Postulates of Quantum Mechanics

Particle in a box: Setting up of Schrodinger equation for one-dimensional box and its solution; Comparison with free particle eigenfunctions and eigenvalues. Properties of PB wave functions (normalisation, orthogonality, probability distribution); Expectation values of x, x^2, p_x and p_x^2 and their significance in relation to the uncertainty principle; Extension of the problem to two and three dimensions and the concept of degenerate energy levels

Simple Harmonic Oscillator: setting up of the Schrodinger stationary equation, energy expression (without derivation), expression of wave function for n = 0 and n = 1 (without derivation) and their characteristic features

Reference Books:

1. Atkins, P. W. & Paula, J. de *Atkins', Physical Chemistry*, Oxford University Press
2. Castellan, G. W. *Physical Chemistry*, Narosa
3. McQuarrie, D. A. & Simons, J. D. *Physical Chemistry: A Molecular Approach*, Viva Press
4. Levine, I. N. *Physical Chemistry*, Tata McGraw-Hill
5. Rakshit, P.C., *Physical Chemistry*, Sarat Book House
6. Moore, W. J. *Physical Chemistry*, Orient Longman
7. Mortimer, R. G. *Physical Chemistry*, Elsevier
8. Denbigh, K. *The Principles of Chemical Equilibrium* Cambridge University Press

9. Engel, T. & Reid, P. *Physical Chemistry*, Pearson
10. Levine, I. N. *Quantum Chemistry*, PHI
11. Atkins, P. W. *Molecular Quantum Mechanics*, Oxford
12. Zemansky, M. W. & Dittman, R.H. *Heat and Thermodynamics*, Tata-McGraw-Hill
13. Rastogi, R. P. & Misra, R.R. *An Introduction to Chemical Thermodynamics*, Vikas
14. Klotz, I.M., Rosenberg, R. M. *Chemical Thermodynamics:Basic Concepts and Methods* Wiley
15. Glasstone, S. *An Introduction to Electrochemistry*, East-West Press

C5P: Physical Chemistry-II Lab Dr. Nabakumar Bera (NKB) **Credits 02**

LAB

(60 Lectures)

Experiment 1: Study of viscosity of unknown liquid (glycerol, sugar) with respect to water

Experiment 2: Determination of partition coefficient for the distribution of I_2 between water and CCl_4

Experiment 3: Determination of K_{eq} for $KI + I_2 = KI_3$, using partition coefficient between water and CCl_4

Experiment 4: Conductometric titration of an acid (strong, weak/ monobasic, dibasic) against base strong

Experiment 5: Study of saponification reaction conductometrically

Experiment 6: Verification of Ostwald's dilution law and determination of K_a of weak acid

Suggested Readings :

1. Viswanathan, B., Raghavan, P.S. *Practical Physical Chemistry* Viva Books (2009)
2. Mendham, J., A. I. Vogel's Quantitative Chemical Analysis 6th Ed., Pearson
3. Harris, D. C. *Quantitative Chemical Analysis*. 6th Ed., Freeman (2007)
4. Palit, S.R., De, S. K. *Practical Physical Chemistry* Science Book Agency
5. *University Hand Book of Undergraduate Chemistry Experiments*, edited by Mukherjee, G. N., University of Calcutta
6. Levitt, B. P. edited *Findlay's Practical Physical Chemistry* Longman Group Ltd.
7. Gurtu, J. N., Kapoor, R., *Advanced Experimental Chemistry* S. Chand & Co. Ltd.

CC-6: Inorganic Chemistry-II Credits 06

C6T: Inorganic Chemistry-II Credits 04

Theory: 60 Lectures

Chemical Bonding-I Smt. Sanchayita Adikari (SA) **(24 Lectures)**

(i) *Ionic bond:* General characteristics, types of ions, size effects, radius ratio rule and its application and limitations. Packing of ions in crystals. Born-Landé equation with derivation and importance of Kapustinskii expression for lattice energy. Madelung constant, Born-Haber cycle and its application, Solvation energy. Defects in solids (elementary idea). Solubility energetics of dissolution process.

(ii) *Covalent bond:* Polarizing power and polarizability, ionic potential, Fazan's rules. Lewis structures, formal charge. Valence Bond Theory. The hydrogen molecule (Heitler-London approach), directional character of covalent bonds, hybridizations, equivalent and non-equivalent hybrid orbitals, Bent's rule, Dipole moments, VSEPR theory, shapes of molecules and ions containing lone pairs and bond pairs (examples from main groups chemistry) and multiple bonding (σ and π bond approach).

Chemical Bonding-II Dr. Tarun Mistri (TM) **(24 Lectures)**

(i) Molecular orbital concept of bonding (The approximations of the theory, Linear combination of atomic orbitals (LCAO)) (elementary pictorial approach): sigma and pi-bonds and delta interaction, multiple bonding. Orbital designations: *gerade*, *ungerade*, HOMO, LUMO. Orbital mixing,. MO diagrams of H_2, Li_2, Be_2, B_2, C_2, N_2, O_2, F_2, and their ions wherever possible; Heteronuclear molecular orbitals: CO, NO, NO^+, CN^-, HF, BeH_2, CO_2 and H_2O. Bond properties: bond orders, bond lengths.

(ii) *Metallic Bond:* Qualitative idea of valence bond and band theories. Semiconductors and insulators, defects in solids.

(iii) *Weak Chemical Forces:* van der Waals forces, ion-dipole forces, dipole-dipole interactions, induced dipole interactions, Instantaneous dipole-induced dipole interactions. Repulsive forces, Intermolecular forces: Hydrogen bonding (theories of hydrogen bonding, valence bond treatment), receptor-guest interactions, Halogen bonds. Effects of chemical force, melting and boiling points.

Radioactivity Smt. Sanchayita Adikari (SA) **(12 Lectures)**

Nuclear stability and nuclear binding energy. Nuclear forces: meson exchange theory. Nuclear models (elementary idea): Concept of nuclear quantum number, magic numbers. Nuclear Reactions: Artificial radioactivity, transmutation of elements, fission, fusion and spallation. Nuclear energy and power generation. Separation and uses of isotopes. Radio chemical methods: principles of determination of age of rocks and minerals, radio carbon dating, hazards of radiation and safety measures.

Suggested Readings :

1. Lee, J. D. *Concise Inorganic Chemistry*, *5th Ed.*, Wiley India Pvt. Ltd., 2008.
2. Huheey, J. E.; Keiter, E.A. & Keiter, R.L. *Inorganic Chemistry, Principles of*

Structure and Reactivity 4th Ed., Harper Collins 1993, Pearson, 2006.
3. Douglas, B.E. and McDaniel, D.H. *Concepts & Models of Inorganic Chemistry* Oxford, 1970.
4. Porterfield, H. W., *Inorganic Chemistry*, Second Edition, Academic Press, 2005.
5. Purecell, K.F. and Kotz, J.C., *An Introduction to Inorganic Chemistry*, Saunders: Philadelphia, 1980.
6. Cotton, F.A., Wilkinson, G., & Gaus, P.L. *Basic Inorganic Chemistry 3rd Ed.;* Wiley India.
7. Gillespie, R. J. and Hargittai, I., The VSEPR Model of Molecular Geometry, Prentice Hall (1992).
8. Albright, T., *Orbital interactions in chemistry*, John Wiley and Sons (2005).
9. Mingos, D.M.P., *Essential trends in inorganic chemistry*. Oxford University Press (1998).
10. Miessler, G. L., Fischer, P. J., Tarr, D. A., *Inorganic Chemistry*, Pearson, 5th Edition.
11. Kaplan, I., *Nuclear Physics*, Addison-Wesley Publishing Company Inc. London, 1964.
12. Friedlander, G., Kennedy, J. W., Macias, E. S. And Miller, J. M., *Nuclear and Radiochemistry*, Wiley, 1981.

C6P: Inorganic Chemistry-II -Lab **Credits 02**

Inorganic Chemistry-II (LAB) **(60 Lectures)**

Dr. Tarun Mistri (TM) & Dr. Sanchayita Adikari (SA)

Iodo-/ Iodimetric Titrations

1. Estimation of Cu(II)
2. Estimation of Vitamin C
3. Estimation of (i) arsenite and (ii) antimony in tartar-emetic iodimetrically
4. Estimation of available chlorine in bleaching powder.

Estimation of metal content in some selective samples

1. Estimation of Cu in brass.
2. Estimation of Cr and Mn in Steel.
3. Estimation of Fe in cement.

Suggested Readings :

1. Mendham, J., *A. I. Vogel's Quantitative Chemical Analysis* 6th Ed., Pearson, 2009.

CC-7: Organic Chemistry-III **Credits 06**

C7T: Organic Chemistry-III **Credits 04**

Theory: 60 Lectures

Chemistry of alkenes and alkynes Dr. Dilip Rout (DR) **(15 Lectures)**

Addition to C=C: mechanism (with evidence wherever applicable), reactivity, regioselectivity (Markownikoff and anti-Markownikoff additions) and stereoselectivity; reactions: hydrogenation, halogenations, iodolactonisation, hydrohalogenation, hydration,

oxymercuration-demercuration, hydroboration-oxidation, epoxidation, *syn* and *anti*-hydroxylation, ozonolysis, addition of singlet and triplet carbenes; electrophilic addition to diene (conjugated dienes and allene); radical addition: HBr addition; mechanism of allylic and benzylic bromination in competition with brominations across C=C; use of NBS; Birch reduction of benzenoid aromatics; interconversion of *E* - and *Z* - alkenes; contra-thermodynamic isomerization of internal alkenes.

Addition to C≡C (in comparison to C=C): mechanism, reactivity, regioselectivity (Markownikoff and anti-Markownikoff addition) and stereoselectivity; reactions: hydrogenation, halogenations, hydrohalogenation, hydration, oxymercuration-demercuration, hydroboration-oxidation, dissolving metal reduction of alkynes (Birch); reactions of terminal alkynes by exploring its acidity; interconversion of terminal and non-terminal alkynes.

Aromatic Substitution Dr. Susovan Mandal (SM) **(10 Lectures)**

Electrophilic aromatic substitution: mechanisms and evidences in favour of it; orientation and reactivity; reactions: nitration, nitrosation, sulfonation, halogenation, Friedel-Crafts reaction; one-carbon electrophiles (reactions: chloromethylation, Gatterman-Koch, Gatterman, Houben-Hoesch, Vilsmeier-Haack, Reimer-Tiemann, Kolbe-Schmidt); *Ipso* substitituion.

Nucleophilic aromatic substitution: addition-elimination mechanism and evidences in favour of it; S_N1 mechanism; cine substitution (benzyne mechanism), structure of benzyne.

Carbonyl and Related Compounds Dr. Ansuman Bej (AB) **(30 Lectures)**

Addition to C=O: structure, reactivity and preparation of carbonyl compounds; mechanism (with evidence), reactivity, equilibrium and kinetic control; Burgi-Dunitz trajectory in nucleophilic additions; formation of hydrates, cyano hydrins and bisulphite adduct; nucleophilic addition-elimination reactions with alcohols, thiols and nitrogen- based nucleophiles; reactions: benzoin condensation, Cannizzaro and Tischenko reactions, reactions with ylides: Wittig and Corey-Chaykovsky reaction; Rupe rearrangement, oxidations and reductions: Clemmensen, Wolff-Kishner, $LiAlH_4$, $NaBH_4$, MPV, Oppenauer, Bouveault-Blanc, acyloin condensation; oxidation of alcohols with PDC and PCC; periodic acid and lead tetraacetate oxidation of 1,2-diols.

Exploitation of acidity of α-H of C=O: formation of enols and enolates; kinetic and thermodynamic enolates; reactions (mechanism with evidence): halogenation of carbonyl compounds under acidic and basic conditions, Hell-Volhard-Zelinsky (H. V. Z.) reaction, nitrosation, SeO_2 (Riley) oxidation; condensations (mechanism with evidence): Aldol, Tollens', Knoevenagel, Claisen-Schmidt, Claisen ester including Dieckmann, Stobbe; Mannich reaction, Perkin reaction, Favorskii rearrangement; alkylation of active methylene compounds; preparation and synthetic applications of diethyl malonate and ethyl acetoacetate; specific enol equivalents (lithium enolates, enamines, aza-enolates and silyl enol ethers) in connection with alkylation, acylation and aldol type reaction.

Elementary ideas of Green Chemistry: Twelve (12) principles of green chemistry; planning of green synthesis; common organic reactions and their counterparts: reactions: Aldol, Friedel-Crafts, Michael, Knoevenagel, Cannizzaro, benzoin condensation and Dieckmann condensation.

Nucleophilic addition to α,β-unsaturated carbonyl system: general principle and mechanism (with evidence); direct and conjugate addition, addition of enolates (Michael reaction), Stetter reaction, Robinson annulation.

Substitution at sp^2 carbon (C=O system): mechanism (with evidence): $B_{AC}2$, $A_{AC}2$, $A_{AC}1$, $A_{AL}1$ (in connection to acid and ester); acid derivatives: amides, anhydrides & acyl halides (formation and hydrolysis including comparison).

Organometallics Dr. Tapas Kumar Adalder (TA) **(5 Lectures)**

Grignard reagent; Organolithiums; Gilman cuprates: preparation and reactions (mechanism with evidence); addition of Grignard and organolithium to carbonyl compounds; substitution on -COX; directed ortho metalation of arenes using organolithiums, conjugate addition by Gilman cuprates; Corey-House synthesis; abnormal behavior of Grignard reagents; comparison of reactivity among Grignard, organolithiums and organocopper reagents; Reformatsky reaction; Blaise reaction; concept of *umpolung* and base-nucleophile dichotomy in case of organometallic reagents.

Suggested Readings:

1. Clayden, J., Greeves, N., Warren, S. *Organic Chemistry*, Second edition, Oxford University Press 2012.
2. Sykes, P. *A guidebook to Mechanism in Organic Chemistry*, Pearson Education, 2003.
3. Smith, J. G. *Organic Chemistry*, Tata McGraw-Hill Publishing Company Limited.
4. Carey, F. A., Guiliano, R. M. *Organic Chemistry*, Eighth edition, McGraw Hill Education, 2012.
5. Loudon, G. M. *Organic Chemistry*, Fourth edition, Oxford University Press, 2008.
6. Norman, R.O. C., Coxon, J. M. *Principles of Organic Synthesis*, Third Edition, Nelson Thornes, 2003.
7. Morrison, R. N. & Boyd, R. N. *Organic Chemistry*, Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).
8. Finar, I. L. *Organic Chemistry (Volume 1)*, Pearson Education.
9. Graham Solomons, T.W., Fryhle, C. B. *Organic Chemistry*, John Wiley & Sons, Inc.
10. March, J. *Advanced Organic Chemistry*, Fourth edition, Wiley.
11. Jenkins, P. R., *Organometallic Reagents in Synthesis*, Oxford Chemistry Primer, Oxford University Press.
12. Ward, R. S., *Bifunctional Compounds*, Oxford Chemistry Primer, Oxford University Press.
13. Ahluwalia, V. K. *Strategies for Green Organic Synthesis*, ANE Books Pvt. Ltd.

C7P: Organic Chemistry-III –Lab **Credits 02**

LAB (60 Lectures) Dr. Ansuman Bej (AB) & Dr. Prasanta Patra (PP)

Experiment -1: Qualitative Analysis of Single Solid Organic Compounds

a) Detection of special elements (N, S, Cl, Br) by Lassaigne's test
b) Solubility and classification (solvents: H_2O, 5% HCl, 5% NaOH and 5% $NaHCO_3$)

c) Detection of the following functional groups by systematic chemical tests: aromatic amino ($-NH_2$), aromatic nitro ($-NO_2$), amido ($-CONH_2$, including imide), phenolic –OH, carboxylic acid (-COOH), carbonyl (-CHO and >C=O); only one test for each functional group is to be reported.
d) Melting point of the given compound
e) Preparation, purification and melting point determination of a crystalline derivative of the given compound
f) Identification of the compound through literature survey.

Each student, during laboratory session, is required to carry out qualitative chemical tests for all the special elements and the functional groups with relevant derivatisation in known and unknown (**at least six)** organic compounds.

Suggested Readings:

1. Vogel, A. I. *Elementary Practical Organic Chemistry,* Part 2: *Qualitative Organic Analysis*, CBS Publishers and Distributors.
2. *University Hand Book of Undergraduate Chemistry Experiments*, edited by Mukherjee, G. N. University of Calcutta, 2003.
3. Mann, F.G. & Saunders, B.C. *Practical Organic Chemistry,* Pearson Education (2009).
4. Furniss, B.S., Hannaford, A.J., Smith, P.W.G., Tatchell, A.R. *Practical Organic Chemistry*, 5th Ed.,Pearson (2012).
5. Clarke, H. T., *A Handbook of Organic Analysis (Qualitative and Quantitative)*, Fourth Edition, CBS Publishers and Distributors (2007).
6. *Practical Workbook Chemistry (Honours), UGBS, Chemistry*, University of Calcutta, 2015.

Skill Enhancement Course (SEC)

SEC-1: Analytical Clinical Biochemistry Credits: 02

SEC1T: Analytical Clinical Biochemistry Credits: 01

THEORY: 30 Lectures

Basic understanding of the structures, properties and functions of carbohydrates, lipids and proteins:

Review of concepts studied in the core course:
Carbohydrates: Biological importance of carbohydrates, Metabolism, Cellular currency of energy (ATP), Glycolysis, Alcoholic and Lactic acid fermentations, Krebs cycle.
Isolation and characterization of polysachharides.
Proteins: Classification, biological importance; Primary and secondary and tertiary structures of proteins: α-helix and β- pleated sheets, Isolation, characterization, denaturation of proteins.
Enzymes: Nomenclature, Characteristics (mention of Ribozymes), Classification; Active site, Mechanism of enzyme action, Stereospecificity of enzymes, Coenzymes and cofactors, Enzyme inhibitors, Introduction to Biocatalysis: Importance in "Green Chemistry" and Chemical Industry.
Lipids: Classification. Biological importance of triglycerides and phosphoglycerides and cholesterol; Lipid membrane, Liposomes and their biological functions and underlying applications.Lipoproteins. Properties, functions and biochemical functions of steroid hormones.
Biochemistry of peptide hormones.
Structure of DNA (Watson-Crick model) and RNA, Genetic Code, Biological roles of DNA and RNA: Replication, Transcription and Translation, Introduction to Gene therapy.
Enzymes: Nomenclature, classification, effect of pH, temperature on enzyme activity, enzyme inhibition.

Biochemistry of disease: A diagnostic approach by blood/ urine analysis.
Blood: Composition and functions of blood, blood coagulation. Blood collection and preservation of samples. Anaemia, Regulation, estimation and interpretation of data for blood sugar, urea, creatinine, cholesterol and bilirubin.
Urine: Collection and preservation of samples. 6. Formation of urine. Composition and estimation of constituents of normal and pathological urine.

SEC1P: Analytical Clinical Biochemistry Credits: 01

Practicals:

Identification and estimation of the following:
1. Carbohydrates – qualitative and quantitative.
2. Lipids – qualitative.
3. Determination of the iodine number of oil.
4. Determination of the saponification number of oil.
5. Determination of cholesterol using Liebermann- Burchard reaction.
6. Proteins – qualitative.

7. Isolation of protein.
8. Determination of protein by the Biuret reaction.
9. Determination of nucleic acids

Reference Books:

- Cooper, T.G. *Tool of Biochemistry*. Wiley-Blackwell (1977).
- Wilson, K. & Walker, J. *Practical Biochemistry.* Cambridge University Press (2009).
- Varley, H., Gowenlock, A.H & Bell, M.: *Practical Clinical Biochemistry*, Heinemann,
- London (1980).
- Devlin, T.M., *Textbook of Biochemistry with Clinical Correlations*, John Wiley &
- Sons, 2010.
- Berg, J.M., Tymoczko, J.L. & Stryer, L. *Biochemistry*, W.H. Freeman, 2002.
- Talwar, G.P. & Srivastava, M. *Textbook of Biochemistry and Human Biology*, 3rd Ed.
- PHI Learning.
- Nelson, D.L. & Cox, M.M. *Lehninger Principles of Biochemistry*, W.H. Freeman,
- 2013.
- O. Mikes, R.A. Chalmers: *Laboratory Handbook of Chromatographic Methods*, D.
- Van Nostrand & Co., 1961.

Or

SEC-1: Pharmaceutical Chemistry — Credits: 02

Dr. Prasanta Patra (PP), Dr. Ansuman Bej (AB) & Dr. Susovan Mandal (SM)

SEC1T: Pharmaceutical Chemistry — Credits: 01

Theory: 30 Lectures

Drugs & Pharmaceuticals

Drug discovery, design and development; Basic Retrosynthetic approach. Synthesis of the representative drugs of the following classes: analgesics agents, antipyretic agents, antiinflammatoryagents (Aspirin, paracetamol, lbuprofen); antibiotics (Chloramphenicol); antibacterial and antifungal agents (Sulphonamides; Sulphanethoxazol, Sulphacetamide, Trimethoprim); antiviral agents (Acyclovir), Central Nervous System agents (Phenobarbital, Diazepam),Cardiovascular (Glyceryl trinitrate), antilaprosy (Dapsone), HIV-AIDS related drugs (AZT- Zidovudine).

Fermentation

Aerobic and anaerobic fermentation. Production of (i) Ethyl alcohol and citric acid, (ii) Antibiotics; Penicillin, Cephalosporin, Chloromycetin and Streptomycin, (iii) Lysine, Glutamic acid, Vitamin B2, Vitamin B12 and Vitamin C.

SEC1P: Pharmaceutical Chemistry — Credits: 01

Dr. Prasanta Patra (PP), Dr. Ansuman Bej (AB) & Dr. Susovan Mandal (SM)

Practicals:

1. Preparation of Aspirin and its analysis.
2. Preparation of magnesium bisilicate (Antacid).

Reference Books:

- Patrick, G. L. *Introduction to Medicinal Chemistry, Oxford University* Press, UK,

2013.
- Singh, H. & Kapoor, V.K. *Medicinal and Pharmaceutical Chemistry*, Vallabh Prakashan, Pitampura, New Delhi, 2012.
- Foye, W.O., Lemke, T.L. & William, D.A.: *Principles of Medicinal Chemistry*, 4th ed., B.I. Waverly Pvt. Ltd. New Delhi.

Generic Elective Syllabus

GE-3 [Interdisciplinary for other department]

GE3: Chemical Energetics, Equilibria, Organic Chemistry-II

Credits 06

GE3T: Chemical Energetics, Equilibria, Organic Chemistry-II **Credits 04**

Theory: 60 Lectures

Section A: Physical Chemistry-II (30 Lectures)

Chemical Energetics Dr. Nabakumar Bera (NKB) **(14 Lectures)**

Intensive and extensive variables; state and path functions; isolated, closed and open systems; zeroth law of thermodynamics; Concept of heat, work, internal energy and statement of first law; enthalpy, H; relation between heat capacities, calculations of q, w, U and H for reversible, irreversible and free expansion of gases Standard states; Heats of reaction; enthalpy of formation of molecules and ions and enthalpy of combustion and its applications; Laws of thermochemistry; bond energy, bond dissociation energy and resonance energy from thermochemical data, Kirchhoff's equations and effect of pressure on enthalpy of reactions; Adiabatic flame temperature; explosion temperature Statement of the second law of thermodynamics; Concept of heat reservoirs and heat engines; Carnot cycle; Physical concept of Entropy; Carnot engine, refrigerator and efficiency; Entropy change of systems and surroundings for various processes and transformations; Auxiliary state functions (G and A) and Criteria for spontaneity and equilibrium.

Chemical Equilibrium: Dr. Pradipta Ghosh (PG) **(08 Lectures)**

Thermodynamic conditions for equilibrium, degree of advancement; Variation of free energy with degree of advancement; Equilibrium constant and standard Gibbs free energy change; Definitions of KP, KC and KX and relation among them; van't Hoff's reaction isotherm, isobar and isochore from different standard states; Shifting of equilibrium due to change in external parameters e.g. temperature and pressure; variation of equilibrium constant with addition to inert gas; Le Chatelier's principle

Ionic Equilibria: Dr. Nabakumar Bera (NKB) **(08 Lectures)**

Strong, moderate and weak electrolytes, degree of ionization, factors affecting degree of ionization, ionization constant and ionic product of water; Ionization of weak acids and bases, pH scale, common ion effect; Salt hydrolysis-calculation of hydrolysis constant, degree of hydrolysis and pH for different salts; Buffer solutions; Solubility and solubility product of sparingly soluble salts – applications of solubility product principle

Suggested Readings :

1. Barrow, G.M. *Physical Chemistry* Tata McGraw Hill (2007).
2. Castellan, G.W. *Physical Chemistry* 4th Ed. Narosa (2004).
3. Kotz, J.C., Treichel, P.M. & Townsend, J.R. *General Chemistry* Cengage Learning India Pvt. Ltd., New Delhi (2009).
4. Mahan, B.H. *University Chemistry* 3rd Ed. Narosa (1998).
5. Ekambaram, S. *General Chemistry*, Pearson.
6. Petrucci, R.H. *General Chemistry* 5th Ed. Macmillan Publishing Co.: New York (1985).
7. Chugh, K.L., Agnish, S.L. *A Text Book of Physical Chemistry* Kalyani Publishers
8. Bahl, B.S., Bahl, A., Tuli, G.D., *Essentials of Physical Chemistry* S. Chand & Co. ltd.
9. Palit, S. R., *Elementary Physical Chemistry* Book Syndicate Pvt. Ltd.
10. Mandal, A. K. *Degree Physical and General Chemistry* Sarat Book House
11. Pahari, S., *Physical Chemistry* New Central Book Agency
12. Pahari, S., Pahari, D., *Problems in Physical Chemistry* New Central Book Agency

Section-B: Organic Chemistry-II **(30 Lectures)**

Functional group app roach for the following reactions (preparations & reactions) to be studied in context to their structures.

Aromatic Hydrocarbons Dr. Prasanta Patra (PP) **06 Lectures**

Benzene: Preparation: from phenol, by decarboxylation, from acetylene, from Benzene sulphonic acid. *Reactions*: electrophilic substitution (general mechanism); nitration (with mechanism), halogenations (chlorination and bromination), sulphonation and Friedel-Craft's reaction (alkylation and acylation) (up to 4 carbons on benzene); side chain oxidation of alkyl benzenes (up to 4 carbons on benzene).

Organometallic Compounds Dr. Prasanta Patra (PP) **(2 Lectures)**

Introduction; *Grignard reagents*: *Preparations* (from alkyl and aryl halide); concept of *umpolung;* Reformatsky reaction.

Aryl Halides Dr. Tapas Kumar Adalder (TA) **(3 Lectures)**

Preparation: (chloro-, bromo- and iodobenzene): from phenol, Sandmeyer reactions. *Reactions (Chlorobenzene):* nucleophilic aromatic substitution (replacement by –OH group) and effect of nitro substituent (activated nucleophilic substitution).

Alcohols, Phenols and Ethers Dr. Prasanta Patra (PP) **(11 Lectures)**

Alcohols: (up to 5 Carbons). *Preparation:* 1°-, 2°- and 3°- alcohols: using Grignard reagent, reduction of aldehydes, ketones, carboxylic acid and esters; *Reactions:* With sodium, HX (Lucas test), oxidation (alkaline KMnO4, acidic dichromate, concentrated HNO3); Oppenauer oxidation;

Diols: Preparation (with OsO4); pinacol- pinacolone rearrangement (with mechanism) (*with symmetrical diols* only).

Phenols: Preparation: cumene hydroperoxide method, from diazonium salts; acidic nature of phenols; *Reactions:* electrophilic substitution: nitration and halogenations;

Reimer -Tiemann reaction, Houben–Hoesch condensation, Schotten –Baumann reaction, Fries rearrangement and Claisen rearrangement.

Ethers: Preparation: Williamson's ether synthesis; *Reaction*: cleavage of ethers with HI.

Carbonyl Compounds Dr. Tapas Kumar Adalder (TA) **(08 Lectures)**

Aldehydes and Ketones (aliphatic and aromatic): (Formaldehye, acetaldehyde, acetone and benzaldehyde): *Preparation:* from acid chlorides, from nitriles and from Grignard reagents; general properties of aldehydes and ketones; *Reactions:* with HCN, ROH, NaHSO3, NH2-G derivatives and with Tollens' and Fehling's reagents; iodoform test; aldol condensation (with mechanism); Cannizzaro reaction (with mechanism),Wittig reaction, benzoin condensation; Clemmensen reduction, Wolff- Kishner reduction and Meerwein-Pondorff- Verley (MPV) reduction.

Suggested Readings:

1. Sethi, A. *Conceptual Organic Chemistry;* New Age International Publisher.
2. Parmar, V. S. *A Text Book of Organic Chemistry*, S. Chand & Sons.
3. Madan, R. L. *Organic Chemistry*, S. Chand & Sons.
4. Wade, L. G., Singh, M. S., *Organic Chemistry, Pearson*.
5. Finar, I. L. *Organic Chemistry* (*Volume 1*), Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).
6. Morrison, R. T. & Boyd, R. N. *Organic Chemistry*, Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).
7. Bahl, A. & Bahl, B.S. *Advanced Organic Chemistry*, S. Chand, 2010.

GE-3P: LAB: Practicals **Credits 02**
(60 Lectures)

Practicals:

Section A: Physical Chemistry-LAB (15x2=30 Lectures)

Dr. Nabakumar Bera (NKB) & Dr. Pradipta Ghosh (PG)

(Minimum **five** experiments to complete)

(I) Thermochemistry (Any **three**)

1. Determination of heat capacity of calorimeter for different volumes
2. Determination of enthalpy of neutralization of hydrochloric acid with sodium hydroxide
3. Determination of enthalpy of ionization of acetic acid
4. Determination of enthalpy of hydration of copper sulphate

(II) Ionic Equilibria (Any **two**)

a) Measurement of pH of different solutions like aerated drinks, fruit juices, shampoos and soaps (use dilute solutions of soaps and shampoos to prevent damage to the glass electrode) using pH-meter and compare it with the indicator method

b) Preparation of buffer solutions and find the pH of an unknown buffer solution by colour matching method (using following buffers)

(i) Sodium acetate-acetic acid

(ii) Ammonium chloride-ammonium hydroxide

c) Study of the solubility of benzoic acid in water

Suggested Readings:

1. *University Hand Book of Undergraduate Chemistry Experiments*, edited by Mukherjee, G. N., University of Calcutta, 2003.
2. Palit, S.R., *Practical Physical Chemistry* Science Book Agency
3. Mukherjee, N.G., *Selected Experiments in Physical Chemistry* J. N. Ghose & Sons
4. Dutta, S.K., *Physical Chemistry Experiments* Bharati Book Stall

Section B: Organic Chemistry-LAB

Dr. Prasanta Patra (PP) & Dr. Tapas Kumar Adalder (TA)

Identification of a pure organic compound

Solid compounds: oxalic acid, tartaric acid, succinic acid, resorcinol, urea, glucose, benzoic acid and salicylic acid.
Liquid Compounds: methyl alcohol, ethyl alcohol, acetone, aniline, dimethylaniline, benzaldehyde, chloroform and nitrobenzene

Suggested Readings:

1. Bhattacharyya, R. C, *A Manual of Practical Chemistry*.
2. Vogel, A.I., Tatchell, A.R., Furnis, B.S., Hannaford, A.J. & Smith, P.W.G., *Textbook of Practical Organic Chemistry*, Prentice-Hall, 5th edition, 1996.
3. Mann, F.G. & Saunders, B.C. *Practical Organic Chemistry* Orient-Longman, 1960.

Vidyasagar University

Curriculum for B.Sc (Honours) in Chemistry

[Choice Based Credit System]

Semester-IV

Course	Course Code	Name of the Subjects	Course Type/ Nature	Teaching Scheme in hour per week			Credit	Marks
				L	T	P		
CC-8		C8T:Physical Chemistry-III	Core Course - 8	4	0	0	6	75
		C8P:Lab		0	0	4		
CC-9		C9T: Inorganic Chemistry - III	Core Course - 9	4	0	0	6	75
		C9P: Lab		0	0	4		
CC-10		C10T: Organic Chemistry -IV	Core Course - 10	4	0	0	6	75
		C10P: Lab		0	0	4		
GE-4		TBD	Generic Elective-4				6	75
SEC-2		**SEC-2** : Basic analytical Chemistry **Or** Chemistry of Cosmetics and Perfumes **Or** Pesticides Chemistry **Or** Fuel Chemistry	Skill Enhancement Course-2	1-1-0/1-0-2			2	50
Semester Total							**26**	**350**

L=Lecture, **T=** Tutorial, **P=**Practical, **CC =** Core Course, **GE**= Generic Elective, **SEC** = Skill Enhancement Course, **TBD =** to be decided

Generic Elective (GE) (Interdisciplinary) from other Department : Papers are to be taken from any of the following discipline: **Mathematics/Physics /Computer Sc/Statistics/Geology/ Electronics/zoology/Botany /Microbiology/Physiology/Biotechnology/Nutrition**

Modalities of selection of Generic Electives (GE): A student shall have to choose **04** Generic Elective (GE1 to GE4) strictly from **02** subjects / disciplines of choice taking exactly **02** courses from each subjects of disciplines. Such a student shall have to study the curriculum of Generic Elective (GE) of a subject or discipline specified for the relevant semester.

Core Course (CC)

CC-8: PHYSICAL CHEMISTRY-III **Credits 06**

C8T: PHYSICAL CHEMISTRY-III **Credits 04**

Course Contents:

a) Application of Thermodynamics – II Dr. Pradipta Ghosh (PG)

Colligative properties: Vapour pressure of solution; Ideal solutions, ideally diluted solutions and colligative properties; Raoult's law; Thermodynamic derivation using chemical potential to derive relations between the four colligative properties [(i) relative lowering of vapour pressure, (ii) elevation of boiling point, (iii) Depression of freezing point, (iv) Osmotic pressure] and amount of solute. Applications in calculating molar masses of normal, dissociated and associated solutes in solution; Abnormal colligative properties

Phase rule: Definitions of phase, component and degrees of freedom; Phase rule and its derivations; Definition of phase diagram; Phase diagram for water, CO_2, Sulphur

First order phase transition and Clapeyron equation; Clausius-Clapeyron equation - derivation and use; Liquid vapour equilibrium for two component systems; Phenol-water system

Three component systems, water-chloroform-acetic acid system, triangular plots

Binary solutions: Ideal solution at fixed temperature and pressure; Principle of fractional distillation; Duhem-Margules equation; Henry's law; Konowaloff's rule; Positive and negative deviations from ideal behavior; Azeotropic solution; Liquid-liquid phase diagram using phenol-water system; Solid-liquid phase diagram; Eutectic mixture

b) Electrical Properties of molecules Dr. Nabakumar Bera (NKB) & Dr. Pradipta Ghosh (PG)

Ionic equilibria: Chemical potential of an ion in solution; Activity and activity coefficients of ions in solution; Debye-Huckel limiting law-brief qualitative description of the postulates involved, qualitative idea of the model, the equation (without derivation) for ion-ion atmosphere interaction potential. Estimation of activity coefficient for electrolytes using Debye-Huckel limiting law; Derivation of mean ionic activity coefficient from the expression of ion-atmosphere interaction potential; Applications of the equation and its limitations NKB

Electromotive Force: Quantitative aspects of Faraday's laws of electrolysis, rules of oxidation/reduction of ions based on half-cell potentials, applications of electrolysis in metallurgy and industry; Chemical cells, reversible and irreversible cells with examples; Electromotive force of a cell and its measurement, Nernst equation; Standard electrode (reduction) potential and its application to different kinds of half-cells. Application of EMF measurements in determining (i) free energy, enthalpy and entropy of a cell reaction, (ii)

equilibrium constants, and (iii) pH values, using hydrogen, quinone-hydroquinone, glass and SbO/Sb_2O_3 electrodes PG

Concentration cells with and without transference, liquid junction potential; determination ofactivity coefficients and transference numbers; Qualitative discussion of potentiometric titrations (acid-base, redox, precipitation) PG

Dipole moment and polarizability: Polarizability of atoms and molecules, dielectric constant and polarisation, molar polarisation for polar and non-polar molecules; Clausius-Mosotti equation and Debye equation (both without derivation) and their application; Determination of dipole moments NKB

C) Quantum Chemistry Dr. Nabakumar Bera (NKB) & Dr. Pradipta Ghosh (PG)

Angular momentum: Commutation rules, quantization of square of total angular momentum and z-component; Rigid rotator model of rotation of diatomic molecule; Schrödinger equation, transformation to spherical polar coordinates; Separation of variables. Spherical harmonics; Discussion of solution NKB

Qualitative treatment of hydrogen atom and hydrogen-like ions: Setting up of Schrödinger equation in spherical polar coordinates, radial part, quantization of energy (only final energy expression); Average and most probable distances of electron from nucleus; Setting up of Schrödinger equation for many-electron atoms (He, Li) NKB

LCAO and HF-SCF: Covalent bonding, valence bond and molecular orbital approaches, LCAO-MO treatment of H_2^+; Bonding and antibonding orbitals; Qualitative extension to H_2; Comparison of LCAO-MO and VB treatments of H_2 and their limitations; Hartree-Fock method development, SCF and configuration interaction (only basics) PG

Atkins, P. W. & Paula, J. de Atkin's, Physical Chemistry, Oxford University Press

Suggested Readings:

1. Castellan, G. W. *Physical Chemistry*, Narosa
2. Atkins, P. W. & Paula, J. de *Atkins', Physical Chemistry*, Oxford University Press
3. McQuarrie, D. A. & Simons, J. D. *Physical Chemistry: A Molecular Approach*, Viva Press
4. Levine, I. N. *Physical Chemistry*, Tata McGraw-Hill
5. Moore, W. J. *Physical Chemistry*, Orient Longman
6. Mortimer, R. G. *Physical Chemistry*, Elsevier
7. Engel, T. & Reid, P. *Physical Chemistry*, Pearson
8. Levine, I. N. *Quantum Chemistry*, PHI
9. Atkins, P. W. *Molecular Quantum Mechanics*, Oxford
10. Engel, T. & Reid, P. *Physical Chemistry*, Pearson
11. Maron, S.H., Prutton, C. F., *Principles of Physical Chemistry*, McMillan
12. Klotz, I.M., Rosenberg, R. M. *Chemical Thermodynamics:Basic Concepts and Methods* Wiley

13. Rastogi, R. P. & Misra, R.R. An Introduction to Chemical Thermodynamics, Vikas
14. Glasstone, S. An Introduction to Electrochemistry, East-West Press

C8P : Lab Dr. Pradipta Ghosh (PG) **Credits 02**

Practical :

Experiment 1: Determination of solubility of sparingly soluble salt in water, in electrolyte with common ions and in neutral electrolyte (using common indicator)

Experiment 2: Potentiometric titration of Mohr's salt solution against standard $K_2Cr_2O_7$ solution

Experiment 3: Determination of K_{sp} for AgCl by potentiometric titration of $AgNO_3$ solution against standard KCl solution

Experiment 4: Effect of ionic strength on the rate of Persulphate – Iodide reaction

Experiment 5: Study of phenol-water phase diagram

Experiment 6: pH-metric titration of acid (mono- and di-basic) against strong base

Suggested Readings:

1. Viswanathan, B., Raghavan, P.S. *Practical Physical Chemistry* Viva Books (2009)
2. Mendham, J., A. I. Vogel's Quantitative Chemical Analysis 6th Ed., Pearson
3. Harris, D. C. *Quantitative Chemical Analysis*. 6th Ed., Freeman (2007)
4. Palit, S.R., De, S. K. *Practical Physical Chemistry* Science Book Agency
5. *University Hand Book of Undergraduate Chemistry Experiments*, edited by Mukherjee, G. N., University of Calcutta
6. Levitt, B. P. edited *Findlay's Practical Physical Chemistry* Longman Group Ltd.
7. Gurtu, J. N., Kapoor, R., *Advanced Experimental Chemistry* S. Chand & Co. Ltd.

CC-9: INORGANIC CHEMISTRY-III **Credit 06**

C9T: INORGANIC CHEMISTRY-III **Credit 04**

Course Contents:

General Principles of Metallurgy Dr. Tarun Mistri (TM)

Chief modes of occurrence of metals based on standard electrode potentials. Ellingham diagrams for reduction of metal oxides using carbon and carbon monoxide as reducing agent. Electrolytic Reduction, Hydrometallurgy. Methods of purification of metals: Electrolytic Kroll process, Parting process, van Arkel-de Boer process and Mond's process, Zone refining.

Chemistry of *s* and *p* Block Elements Dr. Tarun Mistri (TM)

Relative stability of different oxidation states, diagonal relationship and anomalous behaviour of first member of each group. Allotropy and catenation. Study of the following compounds with emphasis on structure, bonding, preparation, properties and uses. Beryllium hydrides and halides. Boric acid and borates, boron nitrides, borohydrides (diborane) and graphitic compounds, silanes, Oxides and oxoacids of nitrogen, phosphorus, sulphur and chlorine. Peroxo acids of sulphur, sulphur-nitrogen compounds, interhalogen compounds, polyhalide ions, pseudohalogens, fluorocarbons and basic properties of halogens.

Noble Gases: Smt. Sanchayita Adikari (SA)
Occurrence and uses, rationalization of inertness of noble gases, Clathrates; preparation and properties of XeF_2, XeF_4 and XeF_6; Nature of bonding in noble gas compounds (Valence bond treatment and MO treatment for XeF_2 and XeF_4). Xenon-oxygen compounds. Molecular shapes of noble gas compounds (VSEPR theory).

Inorganic Polymers: Smt. Sanchayita Adikari (SA)
Types of inorganic polymers, comparison with organic polymers, synthesis, structural aspects and applications of silicones and siloxanes. Borazines, silicates and phosphazenes.

Coordination Chemistry-I Dr. Tarun Mistri (TM)

Coordinate bonding: double and complex salts. Werner's theory of coordination complexes, Classification of ligands, Ambidentate ligands, chelates, Coordination numbers, IUPAC nomenclature of coordination complexes (up to two metal centers), Isomerism in coordination compounds, constitutional and stereo isomerism, Geometrical and optical isomerism in square planar and octahedral complexes.

Suggested Readings:

1. Huheey, J. E.; Keiter, E.A. & Keiter, R.L. *Inorganic Chemistry, Principles of Structure and Reactivity 4th Ed.*, Harper Collins 1993, Pearson,2006.
2. Greenwood, N.N. & Earnshaw A. *Chemistry of the Elements*, Butterworth-Heinemann, 1997.
3. Cotton, F.A., Wilkinson, G., Murrillo, C. A., Bochmann, M., *Advanced Inorganic Chemistry 6th Ed. 1999.*, Wiley.
4. Miessler, G. L. & Donald, A. Tarr. *Inorganic Chemistry* 4th Ed., Pearson, 2010.
5. Purecell, K.F. and Kotz, J.C., *An Introduction to Inorganic Chemistry*, Saunders: Philadelphia, 1980.
6. Mingos, D.M.P., *Essential trends in inorganic chemistry*. Oxford University Press (1998).

C9P: LAB **Credits 02**

Practical:

Dr. Tarun Mistri (TM) & Smt. Sanchayita Adikari (SA)

Complexometric titration

1. Zn(II)
2. Zn(II) in a Zn(II) and Cu(II) mixture.
3. Ca(II) and Mg(II) in a mixture.
4. Hardness of water.

Inorganic preparations

1. $[Cu(CH_3CN)_4]PF_6/ClO_4$
2. *Cis* and *trans* $K[Cr(C_2O_4)_2 (H_2O)_2]$
3. Potassium diaquadioxalatochromate(III)
4. Tetraamminecarbonatocobalt (III) ion
5. Potassium tris(oxalato)ferrate(III)
6. Tris-(ethylenediamine) nickel(II) chloride.
7. $[Mn(acac)_3]$ and $Fe(acac)_3]$ (acac= acetylacetonate)

Suggested Readings:

1. Mendham, J., *A. I. Vogel's Quantitative Chemical Analysis* 6th Ed., Pearson, 2009.
2. *Inorganic Synthesis*, Vol. 1-10.

CC-10: ORGANIC CHEMISTRY-IV **Credits 06**

C10T: ORGANIC CHEMISTRY-IV **Credits 04**

Course Contents:

Nitrogen compounds Dr. Tapas Kumar Adalder (TA)

Amines: Aliphatic & Aromatic: preparation, separation (Hinsberg's method) and identification of primary, secondary and tertiary amines; reaction (with mechanism): Eschweiler–Clarke methylation, diazo coupling reaction, Mannich reaction; formation and reactions of phenylenediamines, diazomethane and diazoacetic ester.

Nitro compounds (aliphatic and aromatic): preparation and reaction (with mechanism): reduction under different conditions; Nef carbonyl synthesis, Henry reaction and conjugate addition of nitroalkane anion.

Alkylnitrile and isonitrile: preparation and reaction (with mechanism): Thorpe nitrile condensation, von Richter reaction.

Diazonium salts and their related compounds: reactions (with mechanism) involving replacement of diazo group; reactions: Gomberg, Meerwein, Japp-Klingermann.

Rearrangements Dr. Ansuman Bej (AB)

Mechanism with evidence and stereochemical features for the following
Rearrangement to electron-deficient carbon: Wagner-Meerwein rearrangement, pinacol rearrangement, dienone-phenol; Wolff rearrangement in Arndt-Eistert synthesis, benzil-benzilic acid rearrangement, Demjanov rearrangement, Tiffeneau–Demjanov rearrangement.

Rearrangement to electron-deficient nitrogen: rearrangements: Hofmann, Curtius, Lossen, Schmidt and Beckmann.

Rearrangement to electron-deficient oxygen: Baeyer-Villiger oxidation, cumene hydroperoxide-phenol rearrangement and Dakin reaction.

Aromatic rearrangements: Migration from oxygen to ring carbon: Fries rearrangement and Claisen rearrangement.
Migration from nitrogen to ring carbon: Hofmann-Martius rearrangement**,** Fischer-Hepp rearrangement, *N*-azo to *C*-azo rearrangement, Bamberger rearrangement, Orton rearrangement and benzidine rearrangement.

Rearrangement reactions by green approach: Fries rearrangement, Claisen rearrangement, Beckmann rearrangement, Baeyer-Villiger oxidation.

The Logic of Organic Synthesis Dr. Susovan Mandal (SM)

Retrosynthetic analysis: disconnections; synthons, donor and acceptor synthons; natural reactivity and *umpolung*; latent polarity in bifunctional compounds: consonant and dissonant polarity; illogical electrophiles and nucleophiles; synthetic equivalents; functional group interconversion and addition (FGI and FGA); C-C disconnections and synthesis: one-group and two-group (1,2- to 1,5-dioxygenated compounds), reconnection (1,6-dicarbonyl); protection-deprotection strategy (alcohol, amine, carbonyl, acid).

Strategy of ring synthesis: thermodynamic and kinetic factors; synthesis of large rings, application of high dilution technique.

Asymmetric synthesis: stereoselective and stereospecific reactions; diastereoselectivity and enantioselectivity (only definition); enantioselectivity: kinetically controlled MPV reduction; diastereoselectivity: addition of nucleophiles to C=O adjacent to a stereogenic centre: Felkin-Anh and Zimmermann-Traxler models.

Organic Spectroscopy Dr. Dilip Rout (DR)

UV Spectroscopy: introduction; types of electronic transitions, end absorption; transition dipole moment and allowed/forbidden transitions; chromophores and auxochromes; Bathochromic and Hypsochromic shifts; intensity of absorptions (Hyper-/Hypochromic effects); application of Woodward's Rules for calculation of λ_{max} for the following systems: conjugated diene, *α,β*-unsaturated aldehydes and ketones (alicyclic, homoannular and heteroannular); extended conjugated systems (dienes, aldehydes and ketones); relative positions of λ_{max} considering conjugative effect, steric effect, solvent effect, effect of pH; effective chromophore concentration: keto-enol systems; benzenoid transitions.

IR Spectroscopy: introduction; modes of molecular vibrations (fundamental and non-fundamental); IR active molecules; application of Hooke's law, force constant; fingerprint region and its significance; effect of deuteration; overtone bands; vibrational coupling in IR; characteristic and diagnostic stretching frequencies of C-H, N-H, O-H, C-O, C-N, C-X, C=C (including skeletal vibrations of aromatic compounds), C=O, C=N, N=O, C≡C, C≡N; characteristic/diagnostic bending vibrations are included; factors affecting stretching frequencies: effect of conjugation, electronic effects, mass effect, bond multiplicity, ring-size, solvent effect, H-bonding on IR absorptions; application in functional group analysis.

NMR Spectroscopy: introduction; nuclear spin; NMR active molecules; basic principles of Proton Magnetic Resonance; equivalent and non-equivalent protons; chemical shift and factors influencing it; ring current effect; significance of the terms: up-/downfield, shielded and deshielded protons; spin coupling and coupling constant (1st order spectra); relative intensities of *first-order* multiplets: Pascal's triangle; chemical and magnetic equivalence in NMR ; elementary idea about *non-first-order* splitting; anisotropic effects in alkene, alkyne, aldehydes and aromatics; NMR peak area, integration; relative peak positions with coupling patterns of common organic compounds (both aliphatic and benzenoid-aromatic); rapid proton exchange; interpretation of NMR spectra of simple compounds.
Applications of IR, UV and NMR spectroscopy for identification of simple organic molecules.

Suggested Readings:

1. Finar, I. L. *Organic Chemistry (Volume 1)*, Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).
2. Finar, I. L. *Organic Chemistry* (*Volume 2: Stereochemistry and the Chemistry of Natural Products*), Dorling Kindersley (India) Pvt. Ltd.(Pearson Education).
3. Norman, R.O. C., Coxon, J. M. *Principles of Organic Synthesis*, Third Edition, Nelson Thornes, 2003.
4. Clayden, J., Greeves, N., Warren, S., *Organic Chemistry,* Second edition, Oxford University Press 2012.
5. Silverstein, R. M., Bassler, G. C., Morrill, T. C. *Spectrometric Identification of Organic Compounds*, John Wiley and Sons, INC, Fifth edition.
6. Kemp, W. *Organic Spectroscopy*, Palgrave.
7. Pavia, D. L. *et al. Introduction to Spectroscopy*, 5th Ed. Cengage Learning India Ed. (2015).

8. Dyer, J. *Application of Absorption Spectroscopy of Organic Compounds*, PHI Private Limited
9. March, J. *Advanced Organic Chemistry*, Fourth edition, Wiley.
10. Harwood, L. M., *Polar Rearrangements*, Oxford Chemistry Primer, Oxford University Press.
11. Bailey, Morgan, Organonitrogen Chemistry, Oxford Chemistry Primer, Oxford University Press.
12. Ahluwalia, V. K. *Strategies for Green Organic Synthesis*, ANE Books Pvt. Ltd.
13. Warren, S. *Organic Synthesis the Disconnection Approach*, John Wiley and Sons.
14. Warren, S., *Designing Organic Synthesis*, Wiley India, 2009.
15. Carruthers, W. *Modern methods of Organic Synthesis*, Cambridge University Press.
16. Willis, C. A., Wills, M., *Organic Synthesis*, Oxford Chemistry Primer, Oxford University Press.

C10P : LAB **Credits 02**

List of Practical

Quantitative Estimations: Dr. Ansuman Bej (AB)

Each student is required to perform all the experiments.

1. Estimation of glycine by Sörensen's formol method
2. Estimation of glucose by titration using Fehling's solution
3. Estimation of sucrose by titration using Fehling's solution
4. Estimation of vitamin-C (reduced)
5. Estimation of aromatic amine (aniline) by bromination (Bromate-Bromide) method
6. Estimation of phenol by bromination (Bromate-Bromide) method
7. Estimation of formaldehyde (Formalin)
8. Estimation of acetic acid in commercial vinegar
9. Estimation of urea (hypobromite method)
10. Estimation of saponification value of oil/fat/ester

Suggested Readings:

1. Arthur, I. V. *Quantitative Organic Analysis*, Pearson
2. *University Hand Book of Undergraduate Chemistry Experiments*, edited by Mukherjee, G. N., University of Calcutta

Skill Enhancement Course (SEC)

SEC-2: BASIC ANALYTICAL CHEMISTRY Credits 02

SEC2T: BASIC ANALYTICAL CHEMISTRY Credits 01

Course Contents:

Dr. Nabakumar Bera (NKB) & Dr. Tarun Mistri (TM)

Introduction: Introduction to Analytical Chemistry and its interdisciplinary nature. Concept of sampling. Importance of accuracy, precision and sources of error in analytical measurements. Presentation of experimental data and results, from the point of view of significant figures. NKB

Analysis of soil: Composition of soil, Concept of pH and pH measurement, Complexometric titrations, Chelation, Chelating agents, use of indicators TM

Analysis of water: Definition of pure water, sources responsible for contaminating water, water sampling methods, water purification methods.TM

Analysis of food products: Nutritional value of foods, idea about food processing and food preservations and adulteration. TM

Chromatography: Definition, general introduction on principles of chromatography, paper chromatography, TLC etc.TM

Ion-exchange: Column, ion-exchange chromatography etc. TM

Analysis of cosmetics: Major and minor constituents and their function TM

SEC-2P: Practical Dr. Tarun Mistri (TM) & Smt. Sanchayita Adikari (SA) Credits 01

A:

1. Determination of pH of soil samples.
2. Estimation of Calcium and Magnesium ions as Calcium carbonate by complexometric titration.
3. Determination of pH, acidity and alkalinity of a water sample.
4. Determination of dissolved oxygen (DO) of a water sample.
5. Identification of adulterants in some common food items like coffee powder, asafoetida, chilli powder, turmeric powder, coriander powder and pulses, etc.
6. Analysis of preservatives and colouring matter.
7. Paper chromatographic separation of mixture of metal ion (Fe^{3+} and Al^{3+}).
8. To compare paint samples by TLC method.
9. Determination of ion exchange capacity of anion / cation exchange resin (using batch procedure if use of column is not feasible).
10. Analysis of deodorants and antiperspirants, Al, Zn, boric acid, chloride, sulphate.

11. Determination of constituents of talcum powder: Magnesium oxide, Calcium oxide, Zinc oxide and Calcium carbonate by complexometric titration.

B:

Suggested Applications (Any one):

a. To study the use of phenolphthalein in traps cases.
b. To analyze arson accelerants.
c. To carry out analysis of gasoline.

C:

Suggested Instrumental demonstrations:

a. Estimation of macro nutrients: Potassium, Calcium, Magnesium in soil samples by flame photometry.
b. Spectrophotometric determination of Iron in Vitamin / Dietary Tablets.
c. Spectrophotometric Identification and Determination of Caffeine and Benzoic Acid in Soft Drink.

Suggested Readings:

1. Willard, H. H. *Instrumental Methods of Analysis*, CBS Publishers.
2. Skoog & Lerry. *Instrumental Methods of Analysis*, Saunders College Publications, New York.
3. Skoog, D.A.; West, D.M. & Holler, F.J. *Fundamentals of Analytical Chemistry 6th Ed.*, Saunders College Publishing, Fort Worth (1992).
4. Harris, D. C. *Quantitative Chemical Analysis*, W. H. Freeman.
5. Dean, J. A. *Analytical Chemistry Notebook*, McGraw Hill.
6. Day, R. A. & Underwood, A. L. *Quantitative Analysis*, Prentice Hall of India.
7. Freifelder, D. Physical Biochemistry *2nd Ed.*, W.H. Freeman and Co., N.Y. USA (1982).
8. Cooper, T.G. *The Tools of Biochemistry*, John Wiley and Sons, N.Y. USA. 16 (1977).
9. Vogel, A. I. *Vogel's Qualitative Inorganic Analysis 7th Ed.*, Prentice Hall.
10. Vogel, A. I. Vogel's *Quantitative Chemical Analysis 6th Ed.*, Prentice Hall.
11. Robinson, J.W. *Undergraduate Instrumental Analysis 5th Ed.*, Marcel Dekker, Inc., New York (1995).

Or

SEC-2: CHEMISTRY OF COSMETICS & PERFUMES Credit 02

SEC2T: CHEMISTRY OF COSMETICS & PERFUMES **Credit 01**

Dr. Prasanta Patra (PP)

Course Contents:

A general study including preparation and uses of the following: Hair dye, hair spray, shampoo, suntan lotions, face powder, lipsticks, talcum powder, nail enamel, creams (cold, vanishing and shaving creams), antiperspirants and artificial flavours. Essential oils and their importance in cosmetic industries with reference to Eugenol, Geraniol, sandalwood oil, eucalyptus, rose oil, 2-phenyl ethyl alcohol, Jasmone, Civetone, Muscone.

SEC2P: Practicals **Credits 01**

Dr. Prasanta Patra (PP) & Dr. Dilip Rout (DR)

1. Preparation of talcum powder.
2. Preparation of shampoo.
3. Preparation of enamels.
4. Preparation of hair remover.
5. Preparation of face cream.
6. Preparation of nail polish and nail polish remover.

Suggested Readings:

• E. Stocchi: *Industrial Chemistry*, Vol -I, Ellis Horwood Ltd. UK.
• P.C. Jain, M. Jain: *Engineering Chemistry*, Dhanpat Rai & Sons, Delhi.
• B.K. Sharma: *Industrial Chemistry*, Goel Publishing House, Meerut.

Or

SEC-2: PESTICIDE CHEMISTRY Credit 02

SEC2T: PESTICIDE CHEMISTRY **Credit 01**

Dr. Prasanta Patra (PP)

Course Contents:

General introduction to pesticides (natural and synthetic), benefits and adverse effects, changing concepts of pesticides, structure activity relationship, synthesis and technical manufacture and uses of representative pesticides in the following classes: Organochlorines (DDT, Gammexene,); Organophosphates (Malathion, Parathion); Carbamates (Carbofuran and carbaryl); Quinones (Chloranil), Anilides (Alachlor and Butachlor).

SEC2P: Practicals **Credit 01**

Dr. Prasanta Patra (PP) & Dr. Dilip Rout (DR)

1. To calculate acidity/alkalinity in given sample of pesticide formulations as per BIS specifications.
2. Preparation of simple organophosphates, phosphonates and thiophosphates

Suggested Readings:

• R. Cremlyn: *Pesticides*, John Wiley.

Or

SEC-2: FUEL CHEMISTRY Credits 02

Dr. Prasanta Patra (PP)

SEC2T: FUEL CHEMISTRY

Course Contents:

Review of energy sources (renewable and non-renewable). Classification of fuels and their calorific value. ***Coal:*** Uses of coal (fuel and nonfuel) in various industries, its composition, carbonization of coal.Coal gas, producer gas and water gas—composition and uses. Fractionation of coal tar, uses of coal tar bases chemicals, requisites of a good metallurgical coke, Coal gasification(Hydro gasification and Catalytic gasification), Coal liquefaction and Solvent Refining. ***Petroleum and Petrochemical Industry:*** Composition of crude petroleum, Refining and different types of petroleum products and their applications. Fractional Distillation (Principle and process), Cracking (Thermal and catalytic cracking), Reforming Petroleum and non-petroleum fuels (LPG, CNG, LNG, bio-gas, fuels derived from biomass), fuel from waste, synthetic fuels (gaseous and liquids), clean fuels. **Petrochemicals:** Vinyl acetate, Propylene oxide, Isoprene, Butadiene, Toluene and its derivatives Xylene. ***Lubricants:*** Classification of lubricants, lubricating oils (conducting and non-conducting) Solid and semisolid lubricants, synthetic lubricants. Properties of lubricants (viscosity index, cloud point, pore point) and their determination.

Suggested Readings:

• E. Stocchi: *Industrial Chemistry*, Vol -I, Ellis Horwood Ltd. UK.
• P.C. Jain, M. Jain: *Engineering Chemistry*, Dhanpat Rai & Sons, Delhi.
• B.K. Sharma: *Industrial Chemistry*, Goel Publishing House, Meerut.

Generic Elective (GE)
[Interdisciplinary for other department]

GE-4: Solutions, Phase Eequilibria, Conductance, Electrochemistry & Analytical and Enviornmetal Chemistry-I Credits 06

GE4T : Solutions, Phase Eequilibria, Conductance, Electrochemistry & Analytical and Enviornmetal Chemistry-I Credits 04

Course Contents:

Section A: Physical Chemistry-III Dr. Pradipta Ghosh (PG)

Solutions Dr. Pradipta Ghosh (PG)

Ideal solutions and Raoult's law, deviations from Raoult's law – non-ideal solutions; Vapour pressure-composition and temperature-composition curves of ideal and non-ideal solutions; Distillation of solutions; Lever rule; Azeotropes Critical solution temperature; effect of impurity on partial miscibility of liquids; Immiscibility of liquids- Principle of steam distillation; Nernst distribution law and its applications, solvent extraction

Phase Equilibria Dr. Pradipta Ghosh (PG)

Phases, components and degrees of freedom of a system, criteria of phase equilibrium; Gibbs Phase Rule and its thermodynamic derivation; Derivation of Clausius – Clapeyron equation and its importance in phase equilibria; Phase diagrams of one-component systems (water and sulphur) and two component systems involving eutectics, congruent and incongruent melting points (lead-silver, $FeCl_3$-H_2O and Na-K only)

Conductance Dr. Pradipta Ghosh (PG)

Conductance, cell constant, specific conductance and molar conductance; Variation of specific and equivalent conductance with dilution for strong and weak electrolytes; Kohlrausch's law of independent migration of ions; Equivalent and molar conductance at infinite dilution and their determination for strong and weak electrolytes; Ostwald's dilution law; Application of conductance measurement (determination of solubility product and ionic product of water); Conductometric titrations (acid-base) Transport Number and principles of Hittorf's and Moving-boundary method

Electromotive force Dr. Pradipta Ghosh (PG)

Faraday's laws of electrolysis, rules of oxidation/reduction of ions based on half-cell potentials, applications of electrolysis in metallurgy and industry; Chemical cells, reversible and irreversible cells with examples; Electromotive force of a cell and its measurement, Nernst equation; Standard electrode (reduction) potential; Electrochemical series; Thermodynamics of a reversible cell, calculation of thermodynamic properties: G, H and S from EMF data Concentration cells with and without transference, liquid junction potential; pH determination using hydrogen electrode and quinhydrone; Qualitative discussion of potentiometric titrations (acid-base, redox, precipitation)

Suggested Readings:

1. Barrow, G.M. *Physical Chemistry* Tata McGraw- Hill (2007).
2. Castellan, G.W. *Physical Chemistry* 4th Ed. Narosa (2004).
3. Kotz, J.C., Treichel, P.M. & Townsend, J.R. *General Chemistry* Cengage Learning India Pvt. Ltd., New Delhi (2009).
4. Mahan, B.H. *University Chemistry* 3rd Ed. Narosa (1998).
5. Petrucci, R.H. *General Chemistry* 5th Ed. Macmillan Publishing Co.: New York (1985).
6. Chugh, K.L., Agnish, S.L. *A Text Book of Physical Chemistry* Kalyani Publishers
7. Bahl, B.S., Bahl, A., Tuli, G.D., *Essentials of Physical Chemistry* S. Chand & Co. ltd.
8. Palit, S. R., *Elementary Physical Chemistry* Book Syndicate Pvt. Ltd.
9. Pahari, S., *Physical Chemistry* New Central Book Agency
10. Pahari, S., Pahari, D., *Problems in Physical Chemistry* New Central Book Agency

Section B: Analytical and Environmental Chemistry

Chemical Analysis Dr. Tarun Mistri (TM)

Gravimetric analysis: solubility product and common ion effect; requirements of gravimetry; gravimetric estimation of chloride, sulphate, lead, barium, nickel, copper and zinc.
Volumetric analysis: primary and secondary standard substances; principles of acidbase, oxidation – reduction and complexometric titrations; indicators: acid-base, redox and metal ion; principles of estimation of mixtures: $NaHCO_3$ and Na_2CO_3 (by acidimetry); iron, copper, manganese and chromium (by redox titration); zinc, aluminum, calcium and magnesium (by complexometric EDTA titration).
Chromatography: chromatographic methods of analysis: column chromatography and thin layer chromatography.

Environmental Chemistry Dr. Tarun Mistri (TM)

The Atmosphere: composition and structure of the atmosphere; troposphere, stratosphere, mesosphere and thermosphere; ozone layer and its role; major air pollutants: CO, SO_2, NO_x and particulate matters – their origin and harmful effects; problem of ozone layer depletion; green house effect; acid rain and photochemical smog; air pollution episodes: air quality standard; air pollution control measures: cyclone collector, electrostatic precipitator, catalytic converter.
The Hydrosphere: environmental role of water, natural water sources, water treatment for industrial, domestic and laboratory uses; water pollutants; action of soaps and detergents, phosphates, industrial effluents, agricultural runoff, domestic wastes; thermal pollution, radioactive pollution and their effects on animal and plant life; water pollution episodes: water pollution control measures : waste water treatment; chemical treatment and microbial treatment; water quality standards: DO, BOD, COD, TDS and hardness parameters; desalination of sea water : reverse osmosis,
electrodialysis.
The Lithosphere: water and air in soil, waste matters and pollutants in soil, waste classification, treatment and disposal; soil pollution and control measures.

Suggested Readings:

1. Banerjee, S. P. *A Text Book of Analytical Chemistry*, The New Book Stall.
2. Gangopadhyay, P. K. *Application Oriented Chemistry*, Book Syndicate.
3. Mondal, A. K & Mondal, S. *Degree Applied Chemistry*, Sreedhar Publications.
4. Banerjee, S. P. *A Text Book of Analytical Chemistry*, The New Book Stall.

GE4T: Practical Dr. Pradipta Ghosh (PG) **Credits 02**

Section A: Physical Chemistry-LAB
(Minimum **six** experiments to complete)

(I) Distribution Law (Any one)
Study of the equilibrium of one of the following reactions by the Distribution method:

$I_2(aq) + I^-(aq) = I_3^-(aq)$ $Cu^{2+}(aq) + xNH_2(aq) = [Cu(NH_3)_x]^{2+}$

(II) Phase equilibria (Any one)

a) Construction of the phase diagram of a binary system (simple eutectic) using cooling curves
b) Determination of the critical solution temperature and composition of the phenol water system and study of the effect of impurities on it

(III) Conductance

a) Determination of dissociation constant of a weak acid (cell constant, equivalent conductance are also determined)
b) Perform the following conductometric titrations: (Any one)
(i) Strong acid vs. strong base
(ii) Weak acid vs. strong base

(IV) Potentiometry

Perform the following potentiometric titrations:

(i) Weak acid vs. strong base
(ii) Potassium dichromate vs. Mohr's salt

Suggested Readings:

1. *University Hand Book of Undergraduate Chemistry Experiments*, edited by Mukherjee, G. N., University of Calcutta, 2003.
2. Palit, S.R., *Practical Physical Chemistry* Science Book Agency
3. Mukherjee, N.G., *Selected Experiments in Physical Chemistry* J. N. Ghose & Sons
4. Dutta, S.K., *Physical Chemistry Experiments* Bharati Book Stall

Section B: Analytic and Environmental Chemistry-LAB

Dr. Tarun Mistri (TM)

1. To find the total hardness of water by EDTA titration.
2. To find the PH of an unknown solution by comparing color of a series of HCl solutions + 1 drop of methyl orange, and a similar series of NaOH solutions + 1 drop of phenolphthalein.
3. To determine the rate constant for the acid catalysed hydrolysis of an ester.
4. Determination of the strength of the H_2O_2 sample.
5. To determine the solubility of a sparingly soluble salt, e.g. KHTa (one bottle)

Suggested Readings:

1. Khosla, B. D.; Garg, V. C. & Gulati, A. *Senior Practical Physical Chemistry*, R. Chand & Co.: New Delhi (2011).
2. Ghosal, Mahapatra & Nad, *An Advanced Course in Practical Chemistry*, New Central Book Agency.
3. *University Hand Book of Undergraduate Chemistry Experiments*, edited by Mukherjee, G. N. University of Calcutta, 2003.
4. Das, S. C., Chakraborty, S. B., *Practical Chemistry*.

Vidyasagar University

Curriculum for B.Sc. (Honours) in Chemistry [Choice Based Credit System]

Semester-V

Course	Course Code	Name of the Subjects	Course Type/ Nature	Teaching Scheme in hour per week			Credit	Marks
				L	T	P		
CC- 11		**C11T:** Inorganic Chemistry - IV	Core Course-11	4	0	0	6	75
		- Lab		0	0	4		
CC- 12		**C12T**: Organic Chemistry - V	Core Course-12	4	0	0	6	75
		- Lab		0	0	4		
DSE-1		**DSE1T**: Advanced Physical Chemistry	Discipline Specific Electives -1	4	0	0	6	75
		- Lab		0	0	4		
DSE-2		**DSE2T:** Analytical Methods in Chemistry **Or** Instrumental Methods of Chemical Analysis	Discipline Specific Electives -2	4	0	0	6	75
		- Lab		0	0	4		
Semester Total							**24**	**300**

L= Lecture, **T=** Tutorial, **P =** Practical, **CC -** Core Course, **TBD -** To be decided, **DSE:** Discipline Specific Elective.

Semester-V

List of Core Course (CC)

CC-11: Inorganic Chemistry - IV

CC-12: Organic Chemistry - V

Discipline Specific Electives (DSE)

DSE-1: Advanced Physical Chemistry

DSE-2: Analytical Methods in Chemistry
Or
DSE-2: Instrumental Methods of Chemical Analysis

SEMESTER –V

Core Courses (CC)

CC-11: Inorganic Chemistry - IV **Credits 06**

C11T: Inorganic Chemistry - IV **Credits 04**

Course Contents:

Coordination Chemistry-II Dr. Tarun Mistri (TM) & Smt. Sanchayita Adikari (SA)

VB description and its limitations. Elementary Crystal Field Theory: splitting of d^n configurations in octahedral, square planar and tetrahedral fields, crystal field stabilization energy (CFSE) in weak and strong fields; pairing energy. Spectrochemical series. Jahn- Teller distortion. Octahedral site stabilization energy (OSSE). Metal-ligand bonding (MO concept, elementary idea), sigma- and pi-bonding in octahedral complexes (qualitative pictorial approach) and their effects on the oxidation states of transitional metals (examples). Magnetism and Colour: Orbital and spin magnetic moments, spin only moments of d^n ions and their correlation with effective magnetic moments, including orbital contribution; quenching of magnetic moment: super exchange and antiferromagnetic interactions (elementary idea with examples only); d-d transitions; L-S coupling; qualitative Orgel diagrams for $3d^1$ to $3d^9$ ions. Racah parameter. Selection rules for electronic spectral transitions; spectrochemical series of ligands; charge transfer spectra (elementary idea).

Chemistry of d- and f- block elements Smt. Sanchayita Adikari (SA)

Transition Elements: Smt. Sanchayita Adikari (SA)

General comparison of 3d, 4d and 5d elements in term of electronic configuration, oxidation states, redox properties, coordination chemistry.

Lanthanoids and Actinoids: Smt. Sanchayita Adikari (SA)

General Comparison on Electronic configuration, oxidation states, colour, spectral and magnetic properties; lanthanide contraction, separation of lanthanides (ion-exchange method only).

Suggested Readings:

1. Huheey, J. E.; Keiter, E.A. & Keiter, R.L. *Inorganic Chemistry, Principles of Structure and Reactivity 4th Ed.*, Harper Collins 1993, Pearson,2006.
2. Greenwood, N.N. & Earnshaw A. *Chemistry of the Elements*, Butterworth-Heinemann. 1997.
3. Cotton, F.A., Wilkinson, G., Murrillo, C. A., Bochmann, M., *Advanced Inorganic Chemistry 6th Ed. 1999.*, Wiley.

4. Atkin, P. *Shriver & Atkins' Inorganic Chemistry* 5th Ed. Oxford University Press (2010).
5. Purecell, K.F. and Kotz, J.C., *An Introduction to Inorganic Chemistry*, Saunders: Philadelphia, 1980.
6. Sinha, S. P., Ed., Lanthanide and Actinide Research (Journal, Vol. 1, 1986).
7. Wulfsberg, G., Principles of Descriptive Inorganic Chemistry, Brooks/Cole: Monterey, CA, 1987.

C11P : LAB **Credits 02**

Dr. Tarun Mistri (TM) & Smt. Sanchayita Adikari (SA)

Practicals :

Chromatography of metal ions

Principles involved in chromatographic separations. Paper chromatographic separation of following metal ions:

1. Ni (II) and Co (II)
2. Fe (III) and Al (III)

Gravimetry

1. Estimation of Ni(II) using Dimethylglyoxime (DMG).
2. Estimation of copper as CuSCN.
3. Estimation of Al(III) by precipitating with oxine and weighing as $Al(oxine)_3$ (aluminium oxinate).
4. Estimation of chloride.

Spectrophotometry

1. Measurement of 10Dq by spectrophotometric method.
2. Determination of λ_{max} of $[Mn(acac)_3]$ and $[Fe(acac)_3]$ complexes.

Suggested Readings:

1. Mendham, J., *A. I. Vogel's Quantitative Chemical Analysis* 6th Ed., Pearson, 2009.

CC-12: Organic Chemistry - V **Credits 06**

C12T: Organic Chemistry - V **Credits 04**

Course Contents:

Carbocycles and Heterocycles Dr. Ansuman Bej (AB)

Polynuclear hydrocarbons and their derivatives: synthetic methods include Haworth, Bardhan-Sengupta, Bogert-Cook and other useful syntheses (with mechanistic details); fixation of double bonds and Fries rule; reactions (with mechanism) of naphthalene, anthracene, phenanthrene and their derivatives.

Heterocyclic compounds: 5- and 6-membered rings with one heteroatom; reactivity, orientation and important reactions (with mechanism) of furan, pyrrole, thiophene and pyridine; synthesis (including retrosynthetic approach and mechanistic details): pyrrole: Knorr synthesis, Paal-Knorr synthesis, Hantzsch; furan: Paal-Knorr synthesis, Feist-Benary synthesis and its variation; thiophenes: Paal-Knorr synthesis, Hinsberg synthesis; pyridine: Hantzsch synthesis; benzo-fused 5- and 6-membered rings with one heteroatom: reactivity, orientation and important reactions (with mechanistic details) of indole, quinoline and isoquinoline; synthesis (including retrosynthetic approach and mechanistic details): indole: Fischer, Madelung and Reissert; quinoline: Skraup, Doebner- Miller, Friedlander; isoquinoline: Bischler-Napieralski synthesis.

Cyclic Stereochemistry Dr. Susovan Mandal (SM)

Alicyclic compounds: concept of I-strain; conformational analysis: cyclohexane, mono and disubstituted cyclohexane; symmetry properties and optical activity; topomerisation; ring-size and ease of cyclisation; conformation & reactivity in cyclohexane system: consideration of steric and stereoelectronic requirements; elimination (E2, E1), nucleophilic substitution (S_N1, S_N2, S_Ni, NGP), merged substitution-elimination; rearrangements; oxidation of cyclohexanol, esterification, saponification, lactonisation, epoxidation, pyrolytic *syn* elimination and fragmentation reactions.

Pericyclic reactions Dr. Dilip Rout (DR) & Dr. Tapas Kumar Adalder (TA)

Mechanism, stereochemistry, regioselectivity in case of

Electrocyclic reactions: FMO approach involving 4π- and 6π-electrons (thermal and photochemical) and corresponding cycloreversion reactions.

Cycloaddition reactions: FMO approach, Diels-Alder reaction, photochemical [2+2] cycloadditions.

Sigmatropic reactions: FMO approach, sigmatropic shifts and their order; [1,3]- and [1,5]-H shifts and [3,3]-shifts with reference to Claisen and Cope rearrangements.

Carbohydrates Dr. Dilip Rout (DR)

Monosaccharides: Aldoses up to 6 carbons; structure of D-glucose & D-fructose (configuration & conformation); ring structure of monosaccharides (furanose and pyranose forms): Haworth representations and non-planar conformations; anomeric effect (including stereoelectronic explanation); mutarotation; epimerization; reactions (mechanisms in relevant cases): Fischer glycosidation, osazone formation, bromine-water oxidation, HNO_3 oxidation, selective oxidation of terminal $–CH_2OH$ of aldoses, reduction to alditols, Lobry de Bruyn-van Ekenstein rearrangement; stepping–up (Kiliani-Fischer method) and stepping–down (Ruff's & Wohl's methods) of aldoses;

end-group-interchange of aldoses; acetonide (isopropylidene) and benzylidene protections; ring-size determination; Fischer's proof of configuration of (+)-glucose.

Disaccharides: Glycosidic linkages, concept of glycosidic bond formation by glycosyl donor-acceptor; structure of sucrose, inversion of cane sugar.

Polysaccharides: starch (structure and its use as an indicator in titrimetric analysis).

Bio-molecules Dr. Susovan Mandal (SM) & Dr. Prasanta Patra (PP)

Amino acids: synthesis with mechanistic details: Strecker, Gabriel, acetamido malonic ester, azlactone, Bücherer hydantoin synthesis, synthesis involving diketopiperazine; isoelectric point, zwitterions; electrophoresis, reaction (with mechanism): ninhydrin reaction, Dakin-West reaction; resolution of racemic amino acids.

Peptides: peptide linkage and its geometry; syntheses (with mechanistic details) of peptides using *N*-protection & C-protection, solid-phase (Merrifield) synthesis; peptide sequence: *C*-terminal and *N*-terminal unit determination (Edman, Sanger & 'dansyl' methods); partial hydrolysis; specific cleavage of peptides: use of CNBr.

Nucleic acids: pyrimidine and purine bases (only structure & nomenclature); nucleosides and nucleotides corresponding to DNA and RNA; mechanism for acid catalysed hydrolysis of nucleosides (both pyrimidine and purine types); comparison of alkaline hydrolysis of DNA and RNA; elementary idea of double helical structure of DNA (Watson-Crick model); complimentary base–pairing in DNA.

Suggested Readings:

1. Clayden, J., Greeves, N., Warren, S. *Organic Chemistry*, Second edition, Oxford University Press 2012.
2. Eliel, E. L. & Wilen, S. H. *Stereochemistry of Organic Compounds*, Wiley: London.
3. Nasipuri, D. *Stereochemistry of Organic Compounds*, Wiley Eastern Limited.
4. Fleming, I. *Molecular Orbitals and Organic Chemical reactions*, Reference/Studen Edition, Wiley, 2009.
5. Fleming, I. *Pericyclic Reactions*, Oxford Chemistry Primer, Oxford University Press.
6. Gilchrist, T. L. & Storr, R. C. *Organic Reactions and Orbital symmetry*, Cambridge University Press.
7. Finar, I. L. *Organic Chemistry (Volume 1)*, Dorling Kindersley (India) Pvt. Ltd.(Pearson Education).
8. Finar, I. L. *Organic Chemistry* (*Volume 2: Stereochemistry and the Chemistry of Natural Products*), Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).
9. Morrison, R. T. & Boyd, R. N. *Organic Chemistry*, Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).
10. Loudon, G. M. *Organic Chemistry*, Fourth edition, Oxford University Press.

11. James, J., Peach, J. M. *Stereochemistry at a Glance*, Blackwell Publishing, 2003.
12. Robinson, M. J. T., *Stereochemistry*, Oxford Chemistry Primer, Oxford University Press, 2005.
13. Davis, B. G., Fairbanks, A. J., *Carbohydrate Chemistry*, Oxford Chemistry Primer, Oxford University Press.
14. Joule, J. A. Mills, K. *Heterocyclic Chemistry*, Blackwell Science.
15. Acheson, R.M. *Introduction to the Chemistry of Heterocyclic compounds*, John Wiely & Sons (1976).
16. Gilchrist, T. L. *Heterocyclic Chemistry*, 3rd edition, Pearson.
17. Davies, D. T., *Heterocyclic Chemistry*, Oxford Chemistry Primer, Oxford University Press.
18. Organic Chemistry, Paula Bruice

C12P : LAB **Credits 06**

Practicals : Dr. Dilip Rout (DR) & Dr. Prasanta Patra (PP)

A. Chromatographic Separations

1. TLC separation of a mixture containing 2/3 amino acids
2. TLC separation of a mixture of dyes (fluorescein and methylene blue)
3. Column chromatographic separation of leaf pigments from spinach leaves
4. Column chromatographic separation of mixture of dyes
5. Paper chromatographic separation of a mixture containing 2/3 amino acids
6. Paper chromatographic separation of a mixture containing 2/3 sugars

B. **Spectroscopic Analysis of Organic Compounds**

1. Assignment of labelled peaks in the ^{1}H NMR spectra of the known organic compounds explaining the relative δ-values and splitting pattern.

2. Assignment of labelled peaks in the IR spectrum of the same compound explaining the relative frequencies of the absorptions (C-H, O-H, N-H, C-O, C-N, C-X, C=C, C=O, N=O, C≡C, C≡N stretching frequencies; characteristic bending vibrations are included).

3. The students must record full spectral analysis of **at least 15 (fifteen)** compounds from the following list:
(i) 4′-Bromoacetanilide (ii) 2-Bromo-4'-methylacetophenone (iii) Vanillin (iv) 2′-Methoxyacetophenone (v) 4-Aminobenzoic acid (vi) Salicylamide (vii) 2′-Hydroxyacetophenone (viii) 1,3-Dinitrobenzene (ix) *trans*-Cinnamic acid (x) *trans*-4-Nitrocinnamaldehyde (xi) Diethyl fumarate (xii) 4-Nitrobenzaldehyde (xiii) 4′-Methylacetanilide (xiv) Mesityl oxide (xv) 2-Hydroxybenzaldehyde (xvi) 4-Nitroaniline (xvii) 2-Hydroxy-3-nitrobenzaldehyde (xviii) 2,3-Dimethylbenzonitrile (xix) Pent-1-yn-3-ol (xx) 3-Nitrobenzaldehyde (xxi) 3-Ethoxy-4-hydroxybenzaldehyde (xxii) 2-Methoxybenzaldehyde (xxiii) Methyl 4-hydroxybenzoate (xxiv) Methyl 3-hydroxybenzoate (xxv) 3-Aminobenzoic acid (xxvi) Ethyl 3-aminobenzoate (xxvii) Ethyl 4-aminobenzoate (xxviii) 3-nitroanisole (xxix) 5-Methyl-2-nitroanisole (xxx) 3′-Methylacetanilide

Suggested Readings:

1. *University Hand Book of Undergraduate Chemistry Experiments*, edited by Mukherjee, G. N. University of Calcutta, 2003.
2. *Practical Workbook Chemistry (Honours), UGBS, Chemistry*, University of Calcutta, 2015
3. Furniss, B.S.; Hannaford, A.J.; Smith, P.W.G.; Tatchell, A.R. *Practical Organic Chemistry, 5th Ed.*, Pearson (2012).
4. Mann, F.G. & Saunders, B.C. *Practical Organic Chemistry*, Pearson Education.

Discipline Specific Electives (DSE)

DSE -1: Advanced Physical Chemistry **Credits 06**

DSE1T: Advanced Physical Chemistry **Credits 04**

Course Contents:

a) Crystal Structure Dr. Pradipta Ghosh (PG)

Bravais Lattice and Laws of Crystallography: Types of solid, Bragg's law of diffraction; Laws of crystallography (Haüy's law and Steno's law); Permissible symmetry axes in crystals; Lattice, space lattice, unit cell, crystal planes, Bravais lattice. Packing of uniform hard sphere, close packed arrangements (fcc and hcp); Tetrahedral and octahedral voids. Void space in p-type, F-type and I-type cubic systems

Crystal planes: Distance between consecutive planes [cubic, tetragonal and orthorhombic lattices]; Indexing of planes, Miller indices; calculation of d_{hkl}; Relation between molar mass and unit cell dimension for cubic system; Bragg's law (derivation)

Determination of crystal structure: Powder method; Structure of NaCl and KCl crystals

b) Statistical Thermodynamics Dr. Nabakumar Bera (NKB)

Configuration: Macrostates, microstates and configuration; calculation with harmonic oscillator; variation of W with E; equilibrium configuration

Boltzmann distribution: Thermodynamic probability, entropy and probability, Boltzmann distribution formula (with derivation); Applications to barometric distribution; Partition function, concept of ensemble - canonical ensemble and grand canonical ensembles

Partition function: molecular partition function and thermodynamic properties, Maxwell's speed distribution; Gibbs' paradox

c) Special selected topics Dr. Nabakumar Bera (NKB) & Dr. Pradipta Ghosh (PG)

Specific heat of solid: Coefficient of thermal expansion, thermal compressibility of solids; Dulong –Petit's law; Perfect Crystal model, Einstein's theory – derivation from partition function, limitations; Debye's T^3 law – analysis at the two extremes NKB

3rd law: Absolute entropy, Plank's law, Calculation of entropy, Nernst heat theorem NKB

Adiabatic demagnetization: Approach to zero Kelvin, adiabatic cooling, demagnetization, adiabatic demagnetization – involved curves NKB

Polymers: Classification of polymers, nomenclature, Molecular forces and chemical bonding in polymers, Texture of Polymers; Criteria for synthetic polymer formation; Relationships between functionality, extent of reaction and degree of polymerization; Mechanism and kinetics of step growth and copolymerization; Conducting polymers PG

Suggested Readings:

1. Castellan, G. W. *Physical Chemistry*, Narosa
2. Levine, I. N. *Physical Chemistry*, Tata McGraw-Hill
3. Moore, W. J. *Physical Chemistry*, Orient Longman
4. Atkins, P. W. & Paula, J. de *Atkins'*, *Physical Chemistry*, Oxford University Press
5. McQuarrie, D. A. & Simons, J. D. *Physical Chemistry*: A Molecular Approach, Viva Press
6. Engel, T. & Reid, P. *Physical Chemistry*, Pearson
7. Nash, L. K. *Elements of Statistical Thermodynamics*, Dover
8. Rastogi, R. P. & Misra, R.R. *An Introduction to Chemical Thermodynamics*, Vikas
9. Zemansky, M. W. & Dittman, R.H. *Heat and Thermodynamics*, Tata-McGraw-Hill
10. Billmeyer, F. W. *Textbook of Polymer Science*, John Wiley & Sons, Inc.
11. Seymour, R. B. & Carraher, C. E. *Polymer Chemistry: An Introduction*, Marcel Dekker, Inc.
12. Odian, G. *Principles of Polymerization*, Wiley
13. Billmeyer, F. W. *Textbook of Polymer Science*, Wiley Interscience, 1971.

DSE1P: Advanced Physical Chemistry (Lab) Credits 02

Practicals : Dr. Pradipta Ghosh (PG)

Computer programs based on numerical methods for

Programming 1: Roots of equations: (e.g. volume of van der Waals gas and comparison with ideal gas, pH of a weak acid)

Programming 2: Numerical differentiation (e.g., change in pressure for small change in volume of a van der Waals gas, potentiometric titrations)

Programming 3: Numerical integration (e.g. entropy/ enthalpy change from heat capacity data), probability distributions (gas kinetic theory) and mean values

Programming 4: Matrix operations (Application of Gauss-Siedel method in colourimetry)

Programming 5: Simple exercises using molecular visualization software

Suggested Readings:

1. Mc Quarrie, D. A. *Mathematics for Physical Chemistry* University Science Books (2008)
2. Mortimer, R. *Mathematics for Physical Chemistry*. 3rd Ed. Elsevier (2005)
3. Yates, P. *Chemical Calculations*. 2nd Ed. CRC Press (2007)
4. Harris, D. C. *Quantitative Chemical Analysis*. 6th Ed., Freeman (2007) Chapters 3-5
5. Noggle, J. H. *Physical Chemistry on a Microcomputer*. Little Brown & Co. (1985)

DSE-2: Analytical Methods in Chemistry **Credits 06**

DSE2T: Analytical Methods in Chemistry **Credits 04**

Course Contents: Dr. Dilip Rout (DR), Dr. Nabakumar Bera (NKB), Dr. Tarun Mistri (TM), Smt. Sanchayita Adikari (SA) & Dr. Prasanta Patra (PP)

Qualitative and quantitative aspects of analysis: NKB

Sampling, evaluation of analytical data, errors, accuracy and precision, methods of their expression, normal law of distribution if indeterminate errors, statistical test of data; F, Q and t test, rejection of data, and confidence intervals. NKB

Optical methods of analysis:

Origin of spectra, interaction of radiation with matter, fundamental laws of spectroscopy and selection rules, validity of Beer-Lambert's law. NKB

UV-Visible Spectrometry: Basic principles of instrumentation (choice of source, monochromator and detector) for single and double beam instrument; NKB
Basic principles of quantitative analysis: estimation of metal ions from aqueous solution, geometrical isomers, keto-enol tautomers. Determination of composition of metal complexes using Job's method of continuous variation and mole ratio method. TM
Infrared Spectrometry: Basic principles of instrumentation (choice of source, monochromator & detector) for single and double beam instrument; sampling techniques. TM

Structural illustration through interpretation of data, Effect and importance of isotope substitution. TM

Flame Atomic Absorption and Emission Spectrometry: Basic principles of instrumentation (choice of source, monochromator, detector, choice of flame and Burner designs. Techniques of atomization and sample introduction; Method of background correction, sources of chemical interferences and their method of removal. Techniques for the quantitative estimation of trace level of metal ions from water samples. TM

Thermal methods of analysis:

Theory of thermogravimetry (TG), basic principle of instrumentation. SA

Techniques for quantitative estimation of Ca and Mg from their mixture. SA

Electroanalytical methods:

Classification of electroanalytical methods, basic principle of pH metric, potentiometric and conductometric titrations. Techniques used for the determination of equivalence points. Techniques used for the determination of pKa values. NKB

Separation techniques:

Solvent extraction: Classification, principle and efficiency of the technique. PP

Mechanism of extraction: extraction by solvation and chelation. PP

Technique of extraction: batch, continuous and counter current extractions. PP

Qualitative and quantitative aspects of solvent extraction: extraction of metal ions from aqueous solution, extraction of organic species from the aqueous and nonaqueous media. PP

Chromatography: Classification, principle and efficiency of the technique. DR

Mechanism of separation: adsorption, partition & ion exchange. DR

Development of chromatograms: frontal, elution and displacement methods. DR

Qualitative and quantitative aspects of chromatographic methods of analysis: IC, GLC, GPC, TLC and HPLC. PP

Stereoisomeric separation and analysis: Measurement of optical rotation, calculation of Enantiomeric excess (ee)/ diastereomeric excess (de) ratios and determination of enantiomeric composition using NMR, Chiral solvents and chiral shift reagents. Chiral chromatographic techniques using chiral columns (GC and HPLC). DR

Role of computers in instrumental methods of analysis. NKB

Suggested Readings:

1. Mendham, J., *A. I. Vogel's Quantitative Chemical Analysis 6th Ed.*, Pearson, 2009.
2. Willard, H.H. *et al.*: *Instrumental Methods of Analysis*, 7th Ed. Wardsworth Publishing Company, Belmont, California, USA, 1988.
3. Christian, G.D. *Analytical Chemistry*, 6th Ed. John Wiley & Sons, New York, 2004.
4. Harris, D.C.: *Exploring Chemical Analysis*, 9th Ed. New York, W.H. Freeman, 2016.
5. Khopkar, S.M. *Basic Concepts of Analytical Chemistry*. New Age International Publisher, 2009.
6. Skoog, D.A. Holler F.J. & Nieman, T.A. *Principles of Instrumental Analysis*, Cengage Learning India Ed.

7. Mikes, O. *Laboratory Hand Book of Chromatographic & Allied Methods*, Elles Harwood Series on Analytical Chemistry, John Wiley & Sons, 1979.
8. Ditts, R.V. Analytical Chemistry; Methods of separation, van Nostrand, 1974.

DSE2P: Analytical Methods in Chemistry (lab) **Credits 02**

Practical : Dr. Dilip Rout (DR), Dr. Prasanta Patra (PP), Dr. Tarun Mistri (TM), & Dr. Sanchayita Adikari (SA)

I. Separation Techniques

Chromatography: TM & SA

(a) Separation of mixtures

Separation and identification of the monosaccharides present in the given mixture (glucose & fructose) by paper chromatography. Reporting the R_f values.

(b) Separate a mixture of Sudan yellow and Sudan Red by TLC technique and identify them on the basis of their Rf values.

(c) Chromatographic separation of the active ingredients of plants, flowers and juices by TLC

II. Solvent Extractions: DR & PP

To separate a mixture of Ni^{2+} & Fe^{2+} by complexation with DMG and extracting the Ni^{2+}-DMG complex in chloroform, and determine its concentration by spectrophotometry.

Analysis of soil:

(i) Determination of pH of soil.

(ii) Estimation of calcium, magnesium, phosphate

Ion exchange:

Determination of exchange capacity of cation exchange resins and anion exchange resins.

III. Spectrophotometry DR & PP

1. Determination of pKa values of indicator using spectrophotometry.
2. Determination of chemical oxygen demand (COD).
3. Determination of Biological oxygen demand (BOD).

Suggested Readings:

1. Mendham, J., *A. I. Vogel's Quantitative Chemical Analysis 6th Ed.*, Pearson, 2009.
2. Willard, H.H. *et al.*: *Instrumental Methods of Analysis*, 7th Ed. Wardsworth Publishing Company, Belmont, California, USA, 1988.
3. Christian, G.D. *Analytical Chemistry*, 6th Ed. John Wiley & Sons, New York, 2004.
4. Harris, D.C. *Exploring Chemical Analysis*, 9th Ed. New York, W.H. Freeman, 2016.

5. Khopkar, S.M. *Basic Concepts of Analytical Chemistry*. New Age International Publisher, 2009.
6. Skoog, D.A. Holler F.J. and Nieman, T.A. *Principles of Instrumental Analysis*, Cengage Learning India Edition.
7. Mikes, O. & Chalmes, R.A. *Laboratory Handbook of Chromatographic & Allied Methods*, Elles Harwood Ltd. London.
8. Ditts, R.V. *Analytical Chemistry: Methods of separation.* Van Nostrand, New York, 1974.

Or

DSE-2: Instrumental Methods of Chemical Analysis **Credits 06**

Dr. Tarun Mistri (TM) & Smt. Sanchayita Adikari (SA)

DSE2T: Instrumental Methods of Chemical Analysis **Credits 04**

Course Contents:

Introduction to spectroscopic methods of analysis: TM

Recap of the spectroscopic methods covered in detail in the core chemistry syllabus: Treatment of analytical data, including error analysis. Classification of analytical methods and the types of instrumental methods. Consideration of electromagnetic radiation.

Molecular spectroscopy: TM

Infrared spectroscopy:

Interactions with molecules: absorption and scattering. Means of excitation (light sources), separation of spectrum (wavelength dispersion, time resolution), detection of the signal (heat, differential detection), interpretation of spectrum (qualitative, mixtures, resolution), advantages of Fourier Transform (FTIR). Samples and results expected. Applications: Issues of quality assurance and quality control, Special problems for portable instrumentation and rapid detection.

UV-Visible/ Near IR – emission, absorption, fluorescence and photoaccoustic. Excitation sources (lasers, time resolution), wavelength dispersion (gratings, prisms, interference filters, laser, placement of sample relative to dispersion, resolution), Detection of signal (photocells, photomultipliers, diode arrays, sensitivity and S/N), Single and Double Beam instruments, Interpretation (quantification, mixtures, absorption vs. fluorescence and the use of time, photoaccoustic, fluorescent tags).

Separation techniques: SA

Chromatography: Gas chromatography, liquid chromatography, supercritical fluids, Importance of column technology (packing, capillaries), Separation based on increasing number of factors (volatility, solubility, interactions with stationary phase, size, electrical field), Detection: simple vs. specific (gas and liquid), Detection as a means of further analysis (use of tags and coupling to IR and MS), Electrophoresis (plates and capillary) and use with DNA analysis.

Elemental analysis: SA

Mass spectrometry (electrical discharges).

Atomic spectroscopy: Atomic absorption, Atomic emission, and Atomic fluorescence.

Excitation and getting sample into gas phase (flames, electrical discharges, plasmas), Wavelength separation and resolution (dependence on technique), Detection of radiation (simultaneous/scanning, signal noise), Interpretation (errors due to molecular and ionic species, matrix effects, other interferences).

NMR spectroscopy: SA
Principle, Instrumentation, Factors affecting chemical shift, Spin-coupling, Applications.

Electroanalytical Methods: TM

Potentiometry & Voltammetry

Radiochemical Methods: SA
Elementary idea

X-ray analysis and electron spectroscopy (surface analysis): TM
Elementary idea

Suggested Readings:

1. D.A. Skoog, F.J. Holler & S. Crouch (ISBN 0-495-01201-7) *Principles of Instrumental Analysis*, Cengage Learning India Edition, 2007.
2. Willard, Merritt, Dean, Settle, *Instrumental Methods of Analysis*, 7th ed, IBH Book House, New Delhi.
3. Atkins, P.W & Paula, J.D. *Physical Chemistry*, 10th Ed., Oxford University Press (2014).
4. Kakkar, R. *Atomic and Molecular Spectroscopy: Concepts and Applications.* Cambridge University Press, 2015.
5. Castellan, G. W. *Physical Chemistry 4th Ed.*, Narosa (2004).
6. Banwell, C. N. & McCash, E. M. *Fundamentals of Molecular Spectroscopy* 4th Ed.
7. Smith, B.C. *Infrared Spectral Interpretations: A Systematic Approach.* CRC Press, 1998.
8. Moore, W.J., *Physical Chemistry* Orient Blackswan, 1999.

DSE2P: Instrumental Methods of Chemical Analysis (Lab)

Dr. Tarun Mistri (TM) & Smt. Sanchayita Adikari (SA)

Credits 02

Practical :

1. Safety Practices in the Chemistry Laboratory
2. Determination of the isoelectric pH of a protein.
3. Titration curve of an amino acid.
4. Determination of the void volume of a gel filtration column.
5. Determination of a Mixture of Cobalt and Nickel (UV/Vis spec.)
6. Study of Electronic Transitions in Organic Molecules (i.e., acetone in water)
7. IR Absorption Spectra (Study of Aldehydes and Ketones)
8. Determination of Calcium, Iron, and Copper in Food by Atomic Absorption
9. Quantitative Analysis of Mixtures by Gas Chromatography (i.e., chloroform and carbon tetrachloride)

10. Separation of Carbohydrates by HPLC
11. Determination of Caffeine in Beverages by HPLC
12. Potentiometric Titration of a Chloride-Iodide Mixture
13. Cyclic Voltammetry of the Ferrocyanide/ Ferricyanide Couple
14. Nuclear Magnetic Resonance
15. Use of fluorescence to do “presumptive tests” to identify blood or other body fluids.
16. Use of “presumptive tests” for anthrax or cocaine
17. Collection, preservation, and control of blood evidence being used for DNA testing
18. Use of capillary electrophoresis with laser fluorescence detection for nuclear DNA (Y chromosome only or multiple chromosome)
19. Use of sequencing for the analysis of mitochondrial DNA
20. Laboratory analysis to confirm anthrax or cocaine
21. Detection in the field and confirmation in the laboratory of flammable accelerants or explosives
22. Detection of illegal drugs or steroids in athletes
23. Detection of pollutants or illegal dumping
24. Fibre analysis

At least 10 experiments to be performed.

Suggested Readings:

1. Skoog, D.A. Holler F.J. & Nieman, T.A. *Principles of Instrumental Analysis*, Cengage Learning India Ed.
2. Willard, H.H., Merritt, L.L., Dean, J. & Settoe, F.A. *Instrumental Methods of Analysis*, 7th Ed. Wadsworth Publishing Company Ltd., Belmont, California, USA, 1988

Vidyasagar University

Curriculum for B.Sc. (Honours) in Chemistry [Choice Based Credit System]

Semester-VI

Course	Course Code	Name of the Subjects	Course Type/ Nature	Teaching Scheme in hour per week			Credit	Marks
				L	T	P		
CC- 13		**C13T:** Inorganic Chemistry-V	Core Course-13	4	0	0	6	75
		- **Lab**		0	0	4		
CC- 14		**C13T**: Physical Chemistry-V	Core Course-14	4	0	0	6	75
		- **Lab**		0	0	4		
DSE-3		**DSE3T**: Green Chemistry **Or** Inorganic Materials of Industrial Importance	Discipline Specific Electives -3	4	0	0	6	75
		- **Lab**		0	0	4		
DSE-4		**DSE4T:** Polymer Chemistry	Discipline Specific Electives -4	4	0	0	6	75
		- **Lab**		0	0	4		
Semester Total							**24**	**300**

L= Lecture, **T=** Tutorial, **P =** Practical, **CC -** Core Course, **TBD -** To be decided, **DSE:** Discipline Specific Elective.

Semester-VI

List of Core Course (CC)

CC-13: Inorganic Chemistry-V

CC-14: Physical Chemistry-V

Discipline Specific Electives (DSE)

DSE-3: Green Chemistry
Or
DSE- 3: Inorganic Materials of Industrial Importance

DSE-4: Polymer Chemistry

SEMESTER –VI

Core Courses (CC)

CC-13: Inorganic Chemistry-V — Credits 06

C13T: Inorganic Chemistry-V — Credits 04

Course Contents:

Bioinorganic Chemistry Dr. Tarun Mistri (TM)

Elements of life: essential and beneficial elements, major, trace and ultratrace elements. Basic chemical reactions in the biological systems and the role of metal ions (specially Na^+, K^+, Mg^{2+}, Ca^{2+}, $Fe^{3+/2+}$, $Cu^{2+/+}$, and Zn^{2+}). Metal ion transport across biological membrane Na^+/ K^+-ion pump. Dioxygen molecule in life. Dioxygen management proteins: Haemoglobin, Myoglobin, Hemocyanine and Hemerythrin. Electron transfer proteins: Cytochromes and Ferredoxins. Hydrlytic enzymes: carbonate bicarbonate buffering system and carbonic anhydrase and carboxyanhydrase A. Biological nitrogen fixation, Photosynthesis: Photosystem-I and Photosystem-II. Toxic metal ions and their effects, chelation therapy (examples only), Pt and Au complexes as drugs (examples only), metal dependent diseases (examples only)

Organometallic Chemistry Dr. Tarun Mistri (TM) & Smt. Sanchayita Adikari (SA)

Definition and classification of organometallic compounds on the basis of bond type. Concept of hapticity of organic ligands. 18-electron and 16-electron rules (pictorial MO approach). Applications of 18-electron rule to metal carbonyls, nitrosyls, cyanides. General methods of preparation of mono and binuclear carbonyls of 3d series. Structures of mononuclear and binuclear carbonyls. pi-acceptor behaviour of CO, synergic effect and use of IR data to explain extent of back bonding. Zeise's salt: Preparation, structure, evidences of synergic effect. Ferrocene: Preparation and reactions (acetylation, alkylation, metallation, Mannich Condensation). Reactions of organometallic complexes: substitution, oxidative addition, reductive elimination and insertion reactions.

Catalysis by Organometallic Compounds Dr. Tarun Mistri (TM)

Study of the following industrial processes

1. Alkene hydrogenation (Wilkinson's Catalyst)

2. Hydroformylation

3. Wacker Process

4. Synthetic gasoline (Fischer Tropsch reaction)

5. Ziegler-Natta catalysis for olefin polymerization.

Reaction Kinetics and Mechanism Dr. Tarun Mistri (TM)

Introduction to inorganic reaction mechanisms. Substitution reactions in square planar complexes, Trans- effect and its application in complex synthesis, theories of trans effect, Mechanism of nucleophilic substitution in square planar complexes, Thermodynamic and Kinetic stability, Kinetics of octahedral substitution, Ligand field effects and reaction rates, Mechanism of substitution in octahedral complexes.

Suggested Readings:

1. Lippard, S.J. & Berg, J.M. *Principles of Bioinorganic Chemistry* Panima Publishing Company 1994.
2. Huheey, J. E.; Keiter, E.A. & Keiter, R.L. *Inorganic Chemistry, Principles of Structure and Reactivity 4th Ed.*, Harper Collins 1993, Pearson,2006.
3. Greenwood, N.N. & Earnshaw A. *Chemistry of the Elements*, Butterworth-Heinemann, 1997.
4. Cotton, F.A., Wilkinson, G., Murrillo, C. A., Bochmann, M., *Advanced Inorganic Chemistry 6th Ed. 1999.*, Wiley.
5. Bertini, I., Gray, H. B., Lippard, S.J., Valentine, J. S., Viva, 2007.
6. Basolo, F, and Pearson, R.C. *Mechanisms of Inorganic Chemistry*, John Wiley & Sons, NY, 1967.
7. Purecell, K.F. and Kotz, J.C., *An Introduction to Inorganic Chemistry*, Saunders: Philadelphia, 1980.
8. Powell, P. *Principles of Organometallic Chemistry*, Chapman and Hall, 1988.
9. Collman, J. P. *et al. Principles and Applications of Organotransition Metal Chemistry*. Mill Valley, CA: University Science Books, 1987.
10. Crabtree, R. H. *The Organometallic Chemistry of the Transition Metals.* New York, NY: John Wiley, 2000.

C13P: LAB Credits 02

Practical: Dr. Tarun Mistri (TM) & Smt. Sanchayita Adikari (SA)

Qualitative semimicro analysis of mixtures containing four radicals. Emphasis should be given to the understanding of the chemistry of different reactions and to assign the most probable composition.

Cation Radicals: Na^{+}, K^{+}, Ca^{2+}, Sr^{2+}, Ba^{2+}, Al^{3+}, Cr^{3+}, Mn^{2+}/Mn^{4+}, Fe^{3+}, Co^{2+}/Co^{3+}, Ni^{2+}, Cu^{2+}, Zn^{2+}, Pb^{2+}, Cd^{2+}, Bi^{3+}, Sn^{2+}/Sn^{4+}, As^{3+}/As^{5+}, $Sb^{3+/5+}$, NH_4^{+}, Mg^{2+}.

Anion Radicals: F^{-}, Cl^{-}, Br^{-}, BrO_3^{-}, I^{-}, IO_3^{-}, SCN^{-}, S^{2-}, SO_4^{2-}, NO_3^{-}, NO_2^{-}, PO_4^{3-}, AsO_4^{3--}, BO_3^{3-}, CrO_4^{2-} / $Cr_2O_7^{2-}$, $Fe(CN)_6^{4-}$, $Fe(CN)_6^{3-}$.

Insoluble Materials: Al_2O_3(ig), Fe_2O_3(ig), Cr_2O_3(ig), SnO_2, $SrSO_4$, $BaSO_4$, CaF_2, $PbSO_4$.

Suggested Readings:

1. Svehla, G., *Vogel's Qualitative Inorganic Analysis*, Pearson Education, 2012.

CC-14: Physical Chemistry-V — Credits 06

C14T: Physical Chemistry-V — Credits 04

Course Contents:

a) Molecular Spectroscopy Dr. Nabakumar Bera (NKB)

Interaction of electromagnetic radiation with molecules and various types of spectra; Born-Oppenheimer approximation

Rotation spectroscopy: Selection rules, intensities of spectral lines, determination of bond lengths of diatomic and linear triatomic molecules, isotopic substitution

Vibrational spectroscopy: Classical equation of vibration, computation of force constant, amplitude of diatomic molecular vibrations, anharmonicity, Morse potential, dissociation energies, fundamental frequencies, overtones, hot bands, degrees of freedom for polyatomic molecules, modes of vibration, concept of group frequencies; Diatomic vibrating rotator, P, Q, R branches

Raman spectroscopy: Qualitative treatment of Rotational Raman effect; Effect of nuclear spin, Vibrational Raman spectra, Stokes and anti-Stokes lines; their intensity difference, rule of mutual exclusion

Nuclear Magnetic Resonance (NMR) spectroscopy: Principles of NMR spectroscopy, Larmor precession, chemical shift and low resolution spectra, different scales, spin-spin coupling and high resolution spectra, interpretation of PMR spectra of organic molecules

Electron Spin Resonance (ESR) spectroscopy: Its principle, hyperfine structure, ESR of simple radicals

b) Photochemistry Dr. Nabakumar Bera (NKB)

Lambert-Beer's law: Characteristics of electromagnetic radiation, Lambert-Beer's law and its limitations, physical significance of absorption coefficients; Laws of photochemistry, Stark-Einstein law of photochemical equivalence quantum yield, actinometry, examples of low and high quantum yields

Photochemical Processes: Potential energy curves (diatomic molecules), Frank-Condon principle and vibrational structure of electronic spectra; Bond dissociation and principle of determination of dissociation energy (ground state); Decay of excited states by radiative and non-radiative paths; Pre-dissociation; Fluorescence and phosphorescence, Jablonskii diagram;

Rate of Photochemical processes: Photochemical equilibrium and the differential rate of photochemical reactions, Photostationary state; HI decomposition, H_2-Br_2 reaction, dimerisation of anthracene; photosensitised reactions, quenching; Role of photochemical reactions in biochemical processes, photostationary states, chemiluminescence

c) Surface phenomenon Dr. Pradipta Ghosh (PG)

Surface tension and energy: Surface tension, surface energy, excess pressure, capillary rise and surface tension; Work of cohesion and adhesion, spreading of liquid over other surface; Vapour pressure over curved surface; Temperature dependence of surface tension

Adsorption: Physical and chemical adsorption; Freundlich and Langmuir adsorption isotherms; multilayer adsorption and BET isotherm (no derivation required); Gibbs adsorption isotherm and surface excess; Heterogenous catalysis (single reactant); Zero order and fractional order reactions;

Colloids: Lyophobic and lyophilic sols, Origin of charge and stability of lyophobic colloids, Coagulation and Schultz-Hardy rule, Zeta potential and Stern double layer (qualitative idea), Tyndall effect; Electrokinetic phenomena (qualitative idea only); Determination of Avogadro number by Perrin's method; Stability of colloids and zeta potential; Micelle formation

Suggested Readings:

1. Castellan, G. W. Physical Chemistry, Narosa
2. Levine, I. N. Physical Chemistry, Tata McGraw-Hill
3. Atkins, P. W. & Paula, J. de Atkin's, Physical Chemistry, Oxford University Press
4. McQuarrie, D. A. & Simons, J. D. Physical Chemistry: A Molecular Approach, Viva Press
5. Mortimer, R. G. Physical Chemistry, Elsevier
6. Laidler, K. J. Chemical Kinetics, Pearson
7. Banwell, C. N. Fundamentals of Molecular Spectroscopy, Tata-McGraw-Hill
8. Barrow, G. M. Molecular Spectroscopy, McGraw-Hill
9. Hollas, J.M. Modern Spectroscopy, Wiley India
10. McHale, J. L. Molecular Spectroscopy, Pearson Education

11. Wayne, C. E. & Wayne, R. P. Photochemistry, OUP
12. Brown, J. M. Molecular Spectroscopy, OUP
13. Levine, I. N. Quantum Chemistry, PHI
14. Atkins, P. W. Molecular Quantum Mechanics, Oxford

C14P : LAB Credits 02

Practical Dr. Pradipta Ghosh (PG)

Experiment 1: Determination of surface tension of a liquid using Stalagmometer

Experiment 2: Determination of CMC from surface tension measurements

Experiment 3: Verification of Beer and Lambert's Law for $KMnO_4$ and $K_2Cr_2O_7$ solution

Experiment 4: Study of kinetics of $K_2S_2O_8$ + KI reaction, spectrophotometrically

Experiment 5: Determination of pH of unknown buffer, spectrophotometrically

Experiment 6: Spectrophotometric determination of CMC

Suggested Readings:

1. Viswanathan, B., Raghavan, P.S. *Practical Physical Chemistry* Viva Books (2009)
2. Mendham, J., A. I. Vogel's Quantitative Chemical Analysis 6th Ed., Pearson
3. Harris, D. C. *Quantitative Chemical Analysis*. 6th Ed., Freeman (2007)
4. Palit, S.R., De, S. K. *Practical Physical Chemistry* Science Book Agency
5. *University Hand Book of Undergraduate Chemistry Experiments*, edited by Mukherjee, G. N., University of Calcutta
6. Levitt, B. P. edited *Findlay's Practical Physical Chemistry* Longman Group Ltd.
7. Gurtu, J. N., Kapoor, R., *Advanced Experimental Chemistry* S. Chand & Co. Ltd.

Discipline Specific Electives (DSE)

DSE-3: Green Chemistry Credits 06

DSE3T: Green Chemistry Credits 04

Course Contents:

Introduction to Green Chemistry: Dr. Dilip Rout (DR)

What is Green Chemistry? Need for Green Chemistry. Goals of Green Chemistry. Limitations/ Obstacles in the pursuit of the goals of Green Chemistry

Principles of Green Chemistry and Designing a Chemical synthesis: Dr. Dilip Rout (DR)

Twelve principles of Green Chemistry with their explanations and examples and special

emphasis on the following:

- Designing a Green Synthesis using these principles; Prevention of Waste/ byproducts; maximum incorporation of the materials used in the process into the final products , Atom Economy, calculation of atom economy of the rearrangement, addition, substitution and elimination reactions.
- Prevention/ minimization of hazardous/ toxic products reducing toxicity. risk =

  (function) hazard × exposure; waste or pollution prevention hierarchy.

- Green solvents– supercritical fluids, water as a solvent for organic reactions, ionic liquids, fluorous biphasic solvent, PEG, solventless processes, immobilized solvents and how to compare greenness of solvents.

- Energy requirements for reactions – alternative sources of energy: use of microwaves and ultrasonic energy.
- Selection of starting materials; avoidance of unnecessary derivatization – careful use of blocking/protecting groups.

- Use of catalytic reagents (wherever possible) in preference to stoichiometric reagents; catalysis and green chemistry, comparison of heterogeneous and homogeneous catalysis, biocatalysis, asymmetric catalysis and photocatalysis.

- Prevention of chemical accidents designing greener processes, inherent safer design, principle of ISD "What you don't have cannot harm you", greener alternative to Bhopal Gas Tragedy (safer route to carcarbaryl) and Flixiborough accident (safer route to cyclohexanol) subdivision of ISD, minimization, simplification, substitution, moderation and limitation.

- Strengthening/ development of analytical techniques to prevent and minimize the generation of hazardous substances in chemical processes.

Examples of Green Synthesis/ Reactions and some real world cases: Dr. Ansuman Bej (AB)

1. Green Synthesis of the following compounds: adipic acid, catechol, disodium iminodiacetate (alternative to Strecker synthesis)

2. Microwave assisted reactions in water: Hofmann Elimination, methyl benzoate to benzoic acid, oxidation of toluene and alcohols; microwave assisted reactions in organic solvents Diels-Alder reaction and Decarboxylation reaction

3. Ultrasound assisted reactions: sonochemical Simmons-Smith Reaction (Ultrasonic alternative to Iodine)
4 Surfactants for carbon dioxide – replacing smog producing and ozone depleting solvents with CO_2 for precision cleaning and dry cleaning of garments.

5 Designing of Environmentally safe marine antifoulant.
6 Rightfit pigment: synthetic azopigments to replace toxic organic and inorganic pigments.

7 An efficient, green synthesis of a compostable and widely applicable plastic (poly lactic acid) made from corn.

8 Healthier Fats and oil by Green Chemistry: Enzymatic Inter esterification for production of no Trans-Fats and Oils

9 Development of Fully Recyclable Carpet: Cradle to Cradle Carpeting

Future Trends in Green Chemistry: Dr. Tapas Kumar Adalder (TA)

Oxidation reagents and catalysts; Biomimetic, multifunctional reagents; Combinatorial green chemistry; Proliferation of solventless reactions; co crystal controlled solid state synthesis (C^2S^3); Green chemistry in sustainable development.

Suggested Readings:

1. Anastas, P.T. & Warner, J.K.: *Green Chemistry - Theory and Practical*, Oxford University Press (1998).
2. Matlack, A.S. *Introduction to Green Chemistry*, Marcel Dekker (2001).
3. Cann, M.C. & Connely, M.E. *Real-World cases in Green Chemistry*, American Chemical Society, Washington (2000).
4. Ryan, M.A. & Tinnesand, M. *Introduction to Green Chemistry*, American Chemical Society, Washington (2002).
5. Lancaster, M. *Green Chemistry: An Introductory Text* RSC Publishing, 2nd Edition, 2010.

DSE3P: LAB Credits 02

Practical: Dr. Dilip Rout (DR) & Dr. Tapas Kumar Adalder (TA)

1. Safer starting materials

- Preparation and characterization of nanoparticles of gold using tea leaves.

2. Using renewable resources

- Preparation of biodiesel from vegetable/ waste cooking oil.

3. Avoiding waste

Principle of atom economy

- Use of molecular model kit to stimulate the reaction to investigate how the atom economy can illustrate Green Chemistry.
- Preparation of propene by two methods can be studied

$$\text{Triethylamine ion} + OH^- \rightarrow \text{propene} + \text{trimethyl propene} + \text{water}$$

$$\text{1-propanol} \xrightarrow{H_2SO_4/\Delta} \text{propene} + \text{water}$$

- Other types of reactions, like addition, elimination, substitution and rearrangement should also be studied for the calculation of atom economy.

3. Use of enzymes as catalysts

- Benzoin condensation using Thiamine Hydrochloride as a catalyst instead of cyanide.

4. Alternative Green solvents

- Extraction of D-limonene from orange peel using liquid CO2 prepared form dry ice. Mechanochemical solvent free synthesis of azomethines

6. Alternative sources of energy

- Solvent free, microwave assisted one pot synthesis of phthalocyanine complex of copper (II).
- Photoreduction of benzophenone to benzopinacol in the presence of sunlight.

Suggested Readings:

1. Anastas, P.T & Warner, J.C. *Green Chemistry: Theory and Practice,* Oxford University Press (1998).
2. Kirchoff, M. & Ryan, M.A. *Greener approaches to undergraduate chemistry experiment*. American Chemical Society, Washington DC (2002).
3. Ryan, M.A. *Introduction to Green Chemistry*, Tinnesand; (Ed), American Chemical Society, Washington DC (2002).
4. Sharma, R.K.; Sidhwani, I.T. & Chaudhari, M.K. I.K. *Green Chemistry Experiment: A monograph International Publishing House Pvt Ltd. New Delhi*. Bangalore CISBN 978-93-81141-55-7 (2013).
5. Cann, M.C. & Connelly, M. E. *Real world cases in Green Chemistry*, American Chemical Society (2008).
6. Cann, M. C. & Thomas, P. *Real world cases in Green Chemistry*, American Chemical Society (2008).
7. Lancaster, M. *Green Chemistry: An Introductory Text* RSC Publishing, 2nd Edition, 2010.
8. Pavia, D.L., Lampman, G.M., Kriz, G.S. & Engel, R.G. *Introduction to Organic Laboratory Techniques: A Microscale and Macro Scale Approach,* W.B.Saunders, 1995.

Or

DSE- 3: Inorganic Materials of Industrial Importance Credits 06

DSE3T: Inorganic Materials of Industrial Importance Credits 04

Course Contents:

1. Silicate Industries:

Glass: Glassy state and its properties, classification (silicate and non-silicate glasses). Manufacture and processing of glass. Composition and properties of the following types of

glasses: Soda lime glass, lead glass, armoured glass, safety glass, borosilicate glass, fluorosilicate, coloured glass, photosensitive glass.

Ceramics: Important clays and feldspar, ceramic, their types and manufacture. High technology ceramics and their applications, superconducting and semiconducting oxides, fullerenes carbon nanotubes and carbon fibre.

Cements: Classification of cement, ingredients and their role, Manufacture of cement and the setting process, quick setting cements.

2. Fertilizers:

Different types of fertilizers. Manufacture of the following fertilizers: Urea, ammonium nitrate, calcium ammonium nitrate, ammonium phosphates; polyphosphate, superphosphate, compound and mixed fertilizers, potassium chloride, potassium sulphate.

3. Surface Coatings:

Objectives of coatings surfaces, preliminary treatment of surface, classification of surface coatings. Paints and pigments-formulation, composition and related properties. Oil paint, Vehicle, modified oils, Pigments, toners and lakes pigments, Fillers, Thinners, Enamels, emulsifying agents. Special paints (Heat retardant, Fire retardant, Eco-friendly paint, Plastic paint), Dyes, Wax polishing, Water and Oil paints, additives, Metallic coatings (electrolytic and electroless), metal spraying and anodizing.

4. Batteries:

Primary and secondary batteries, battery components and their role, Characteristics of Battery. Working of following batteries: Pb acid, Li-Battery, Solid state electrolyte battery. Fuel cells, Solar cell and polymer cell.

5. Alloys:

Classification of alloys, ferrous and non-ferrous alloys, Specific properties of elements in alloys. Manufacture of Steel (removal of silicon decarbonization, demanganization, desulphurization dephosphorisation) and surface treatment (Ar and heat treatment, nitriding, carburizing). Composition and properties of different types of steels.

6. Chemistry of Nano Materials including Graphene. Syntheses, characterization and applications. Plasmonic materials, Semiconductor, Band gap, Types of Semiconductors, Colour Centres.

7. Catalysis:

General principles and properties of catalysts, homogenous catalysis (catalytic steps and examples) and heterogenous catalysis (catalytic steps and examples) and their industrial applications, Deactivation or regeneration of catalysts.

Phase transfer catalysts, application of zeolites as catalysts.

8. Chemical explosives:

Origin of explosive properties in organic compounds, preparation and explosive properties of lead azide, PETN, cyclonite (RDX). Introduction to rocket propellants.

Suggested Readings:

1. E. Stocchi: *Industrial Chemistry*, Vol-I, Ellis Horwood Ltd. UK.
2. R. M. Felder, R. W. Rousseau: *Elementary Principles of Chemical Processes*, Wiley Publishers, New Delhi.
3. W. D. Kingery, H. K. Bowen, D. R. Uhlmann: *Introduction to Ceramics*, Wiley Publishers, New Delhi.
4. J. A. Kent: Riegel's *Handbook of Industrial Chemistry*, CBS Publishers, New Delhi.
5. P. C. Jain, M. Jain: *Engineering Chemistry*, Dhanpat Rai & Sons, Delhi.
6. R. Gopalan, D. Venkappayya, S. Nagarajan: *Engineering Chemistry*, Vikas Publications, New Delhi.
7. Sharma, B.K. & Gaur, H. *Industrial Chemistry*, Goel Publishing House, Meerut (1996).

DSE3P: LAB **Credits 02**

Practical:

1. Determination of free acidity in ammonium sulphate fertilizer.
2. Estimation of Calcium in Calcium ammonium nitrate fertilizer.
3. Estimation of phosphoric acid in superphosphate fertilizer.
4. Electroless metallic coatings on ceramic and plastic material.
5. Determination of composition of dolomite (by complexometric titration).
6. Analysis of (Cu, Ni); (Cu, Zn) in alloy or synthetic samples.
7. Analysis of Cement.
8. Preparation of pigment (zinc oxide).

Suggested Readings:

1. E. Stocchi: *Industrial Chemistry*, Vol-I, Ellis Horwood Ltd. UK.

2. R. M. Felder, R. W. Rousseau: *Elementary Principles of Chemical Processes*, Wiley Publishers, New Delhi.
3. W. D. Kingery, H. K. Bowen, D. R. Uhlmann: *Introduction to Ceramics*, Wiley Publishers, New Delhi.

4. J. A. Kent: Riegel's *Handbook of Industrial Chemistry*, CBS Publishers, New Delhi.
5. P. C. Jain, M. Jain: *Engineering Chemistry*, Dhanpat Rai & Sons, Delhi.
6. R. Gopalan, D. Venkappayya, S. Nagarajan: *Engineering Chemistry*, Vikas
7. Publications, New Delhi.
8. Sharma, B.K. & Gaur, H. *Industrial Chemistry*, Goel Publishing House, Meerut (1996).

DSE-4: Polymer Chemistry — Credits 06

DSE4T: Polymer Chemistry — Credits 04

Dr. Susovan Mandal (SM) & Dr. Pradipta Ghosh (PG)

Course Contents:

Introduction and history of polymeric materials: PG

Different schemes of classification of polymers, Polymer nomenclature, Molecular forces and chemical bonding in polymers, Texture of Polymers.

Functionality and its importance: SM

Criteria for synthetic polymer formation, classification of polymerization processes, Relationships between functionality, extent of reaction and degree of polymerization. Bi-functional systems, Poly-functional systems.

Kinetics of Polymerization: PG

Mechanism and kinetics of step growth, radical chain growth, ionic chain (both cationic and anionic) and coordination polymerizations, Mechanism and kinetics of copolymerization, polymerization techniques.

Crystallization and crystallinity: PG

Determination of crystalline melting point and degree of crystallinity, Morphology of crystalline polymers, Factors affecting crystalline melting point.

Nature and structure of polymers: SM

Structure Property relationships.

Determination of molecular weight of polymers: PG

(*Mn*, *Mw*, etc) by end group analysis, viscometry, light scattering and osmotic pressure methods. Molecular weight distribution and its significance. Polydispersity index.

Glass transition temperature (Tg) and determination of Tg: PG

Free volume theory, WLF equation, Factors affecting glass transition temperature (Tg).

Polymer Solution: PG

Criteria for polymer solubility, Solubility parameter, Thermodynamics of polymer solutions, entropy, enthalpy, and free energy change of mixing of polymers solutions, Flory- Huggins theory, Lower and Upper critical solution temperatures.

Properties of Polymer:

(Physical, thermal, Flow & Mechanical Properties).

Brief introduction to preparation, structure, properties and application of the following polymers: polyolefins, polystyrene and styrene copolymers, poly(vinyl chloride) and related polymers, poly(vinyl acetate) and related polymers, acrylic polymers, fluoro polymers,

polyamides and related polymers. Phenol formaldehyde resins (Bakelite, Novalac), polyurethanes, silicone polymers, polydienes,

Polycarbonates, Conducting Polymers, [polyacetylene, polyaniline, poly(p-phenylene sulphide polypyrrole, polythiophene)].

Suggested Readings:

1. R.B. Seymour & C.E. Carraher: *Polymer Chemistry: An Introduction*, Marcel Dekker, Inc. New York, 1981.
2. G. Odian: *Principles of Polymerization*, 4th Ed. Wiley, 2004.
3. F.W. Billmeyer: *Textbook of Polymer Science*, 2nd Ed. Wiley Interscience, 1971.
4. P. Ghosh: Polymer Science & Technology, Tata McGraw-Hill Education, 1991.
5. R.W. Lenz: *Organic Chemistry of Synthetic High Polymers.* Interscience Publishers, New York, 1967.

DSE4P: LAB Credits 02

Practical: Dr. Susovan Mandal (SM) & Dr. Pradipta Ghosh (PG)

Polymer synthesis Dr. Susovan Mandal (SM)

1. Free radical solution polymerization of styrene (St) / Methyl Methacrylate (MMA) / Methyl Acrylate (MA) / Acrylic acid (AA).
    a) Purification of monomer
    b) Polymerization using benzoyl peroxide (BPO) / 2,2'-azo-bis-isobutylonitrile (AIBN)
    2. Preparation of nylon 66/6
    3. Interfacial polymerization, preparation of polyester from isophthaloyl chloride (IPC) and phenolphthalein
    4. Redox polymerization of acrylamide
    5. Precipitation polymerization of acrylonitrile
    6. Preparation of urea-formaldehyde resin
    7. Preparations of novalac resin/ resold resin.
    8. Microscale Emulsion Polymerization of Poly(methylacrylate).

Polymer characterization Dr. Pradipta Ghosh (PG)

1. Determination of molecular weight by viscometry:
    (a) Polyacrylamide-aq.$NaNO_2$ solution

    (b) (Poly vinyl proplylidine (PVP) in water
2. Determination of the viscosity-average molecular weight of poly(vinyl alcohol) (PVOH) and the fraction of "head-to-head" monomer linkages in the polymer.
3. Determination of molecular weight by end group analysis: Polyethylene glycol (PEG) (OH group).
4. Testing of mechanical properties of polymers.
5. Determination of hydroxyl number of a polymer using colorimetric method.

Polymer analysis Dr. Susovan Mandal (SM) & Dr. Pradipta Ghosh (PG)

1. Estimation of the amount of HCHO in the given solution by sodium sulphite method
2. Instrumental Techniques
3. IR studies of polymers
4. DSC analysis of polymers
5. Preparation of polyacrylamide and its electrophoresis

*at least 7 experiments to be carried out.

Suggested Readings:

1. M.P. Stevens, *Polymer Chemistry: An Introduction*, 3rd Ed., Oxford University Press, 1999.
2. H.R. Allcock, F.W. Lampe & J.E. Mark, *Contemporary Polymer Chemistry*, 3rd ed. Prentice-Hall (2003)

3. F.W. Billmeyer, *Textbook of Polymer Science*, 3rd ed. Wiley-Interscience (1984)
4. J.R. Fried, *Polymer Science and Technology*, 2nd ed. Prentice-Hall (2003)
5. P. Munk & T.M. Aminabhavi, *Introduction to Macromolecular Science*, 2nd ed. John Wiley & Sons (2002)
6. L. H. Sperling, *Introduction to Physical Polymer Science*, 4th ed. John Wiley & Sons (2005)
7. M.P. Stevens, *Polymer Chemistry: An Introduction* 3rd ed. Oxford University Press (2005).
8. Seymour/ Carraher's Polymer Chemistry, 9th ed. by Charles E. Carraher, Jr. (2013).

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VIDYASAGAR UNIVERSITY

Curriculum for 3-Year B Sc (General)
in

Chemistry

Under Choice Based Credit System (CBCS)
w.e.f 2018-2019

VIDYASAGAR UNIVERSITY

B Sc (General) in Chemistry

[Choice Based Credit System]

Year	Semester	Course Type	Course Code	Course Title	Credit	L-T-P	Marks		
1	I	SEMESTER-I					CA	ESE	TOTAL
		Core-1 (DSC-1A)		Atomic structure, Bonding, General organic chemistry & Aliphatic Hydrocarbons - **Lab**	6	4-0-4	15	60	75
		Core-2 (DSC-2A)		Other Discipline/TBD	6	4-0-4/ 5-1-0	15	60	75
		Core-3 (DSC-3A)		Other Discipline/TBD	6	4-0-4/ 5-1-0	15	60	75
		AECC-1 (Elective)		English/MIL	2	1-1-0	10	40	50
		Semester - I : Total			**20**				**275**
	II	SEMESTER-II							
		Core-4 (DSC-1B)		Chemical Energetics, Equilibria & Functional Organic Chemistry - **Lab**	6	4-0-4	15	60	75
		Core-5 (DSC-2B)		Other Discipline/TBD	6	4-0-4/ 5-1-0	15	60	75
		Core-6 (DSC-3B)		Other Discipline/TBD	6	4-0-4/ 5-1-0	15	60	75
		AECC-2 (Elective)		Environmental Studies	4		20	80	100
		Semester - 2 : Total			**22**				**325**

Year	Semester	Course Type	Course Code	Course Title	Credit	L-T-P	Marks		
2	III	SEMESTER-III					CA	ESE	TOTAL
		Core-7 (DSC-1C)		Conductance, Electrochemistry & Functional Organic Chemistry - **Lab**	6	4-0-4	15	60	75
		Core-8 (DSC-2C)		Other Discipline/TBD	6	4-0-4/ 5-1-0	15	60	75
		Core-9 (DSC-3C)		Other Discipline/TBD	6	4-0-4/ 5-1-0	15	60	75
		SEC-1		TBD	2	1-1-0/ 1-0-2	10	40	50
		Semester - 3 : Total			**20**				**275**
	IV	SEMESTER-IV							
		Core-10 (DSC-1D)		Coordination chemistry, State of Matter and Chemical Kinetics - **Lab**	6	4-0-4	15	60	75
		Core-11 (DSC-2D)		Other Discipline/TBD	6	4-0-4/ 5-1-0	15	60	75
		Core-12 (DSC-3D)		Other Discipline/TBD	6	4-0-4/ 5-1-0	15	60	75
		SEC-2		TBD	2	1-1-0/ 1-0-2	10	40	50
				Semester - 4 : Total	**20**				**275**

Year	Semester	Course Type	Course Code	Course Title	Credit	L-T-P	Marks		
3	V	SEMESTER-V					CA	ESE	TOTAL
		DSE-1A		Discipline-1(Chemistry)	6	4-0-4/ 5-1-0	15	60	75
		DSE-2A		Other Discipline/TBD	6	4-0-4/ 5-1-0	15	60	75
		DSE-3A		Other Discipline/TBD	6	4-0-4/ 5-1-0	15	60	75
		SEC-3		TBD	2	1-1-0/ 1-0-2	10	40	50
		Semester - 5 : Total			**20**				**275**
	VI	SEMESTER-VI							
		DSE-1B		Discipline-1(Chemistry)	6	4-0-4/ 5-1-0	15	60	75
		DSE-2B		Other Discipline/TBD	6	4-0-4/ 5-1-0	15	60	75
		DSE-3B		Other Discipline/TBD	6	4-0-4/ 5-1-0	15	60	75
		SEC-4		TBD	2	1-1-0/ 1-0-2	10	40	50
		Semester - 6 : Total			**20**				**275**
	Total in all semester:				**122**				**1700**

CC = Core Course , **AECC** = Ability Enhancement Compulsory Course , **GE** = Generic Elective , **SEC** = Skill Enhancement Course , **DSE** = Discipline Specific Elective , **CA**= Continuous Assessment , **ESE**= End Semester Examination , **TBD**=To be decided , **CT** = Core Theory, **CP**=Core Practical , **L** = Lecture, **T** = Tutorial ,**P** = Practical , **MI**L = Modern Indian Language , **ENV**S = Environmental Studies .

List of Core and Elective Courses

Core Courses (CC)

DSC-1A: Atomic Structure, Bonding, general organic chemistry & aliphatic hydrocarbons
DSC-1B: Chemical Energetics, Equilibria &Functional Organic Chemistry
DSC-1C: Solutions, Phase equilibrium, Conductance, Electrochemistry & Functional Organic Chemistry
DSC-1D: Coordination Chemistry, States of matter Chemical Kinetics

Discipline Specific Electives (DSE)

DSE-1: Analytical Methods in Chemistry
Or
DSE-1: Polymer Chemistry
Or
DSE-1: Instrumental Methods of Chemical Analysis
Or
DSE-1: Organometallics, Bioinorganic Chemistry, Polynuclear hydrocarbons and **UV,** IR Spectroscopy
DSE-2: Applications of Computers in Chemistry.
Or
DSE-2: Green Chemistry
Or
DSE-2: Industrial Chemicals and Environment
Or
DSE-2: Quantum Chemistry, Spectroscopy & Photochemistry
Or
DSE-2: Molecular Modelling & Drug design

Skill Enhancement Course (SEC)

SEC-1: Basic Analytical Chemistry
Or
SEC-1: Chemo informatics
SEC-2: Analytical Clinical Biochemistry
Or
SEC-2: Intellectual Property Rights (IPR)
SEC-3: Pharmaceutical Chemistry
Or
SEC-3: Chemistry of Cosmetics & Perfumes
SEC-4: Pesticide Chemistry
Or
SEC-4: Fuel Chemistry

Core Courses (CC)

DSC-1A(CC-1): Atomic Structure, Bonding, general organic chemistry & aliphatic hydrocarbons Credits 06

DSC1AT: Atomic Structure, Bonding, general organic chemistry & aliphatic hydrocarbons Credits 04

Course Contents:

Section A: Inorganic Chemistry-1

Atomic Structure: Dr. Tarun Mistri (TM)

Review of Bohr's theory and its limitations, dual behaviour of matter and radiation, de Broglie's relation, Heisenberg Uncertainty principle. Hydrogen atom spectra. Need of a new approach to Atomic structure. What is Quantum mechanics? Time independent Schrodinger equation and meaning of various terms in it. Significance of ψ and ψ^2, Schrödinger equation for hydrogen atom. Radial and angular parts of the hydogenic wavefunctions (atomic orbitals) and their variations for 1*s*, 2*s*, 2*p*, 3*s*, 3*p* and 3*d* orbitals (Only graphical representation). Radial and angular nodes and their significance. Radial distribution functions and the concept of the most probable distance with special reference to 1*s* and 2*s* atomic orbitals. Significance of quantum numbers, orbital angular momentum and quantum numbers m_l and m_s. Shapes of *s, p* and *d* atomic orbitals, nodal planes. Discovery of spin, spin quantum number (*s*) and magnetic spin quantum number (m_s). Rules for filling electrons in various orbitals, Electronic configurations of the atoms. Stability of half-filled and completely filled orbitals, concept of exchange energy. Relative energies of atomic orbitals, Anomalous electronic configurations.

Chemical Bonding and Molecular Structure Smt. Sanchayita Adikari (SA)

Ionic Bonding: General characteristics of ionic bonding. Energy considerations in ionic bonding, lattice energy and solvation energy and their importance in the context of stability and solubility of ionic compounds. Statement of Born-Landé equation for calculation of lattice energy, Born-Haber cycle and its applications, polarizing power and polarizability. Fajan's rules, ionic character in covalent compounds, bond moment, dipole moment and percentage ionic character. *Covalent bonding:* VB Approach: Shapes of some inorganic molecules and ions on the basis of VSEPR and hybridization with suitable examples of linear, trigonal planar, square planar, tetrahedral, trigonal bipyramidal and octahedral arrangements. Concept of resonance and resonating structures in various inorganic and organic compounds. MO Approach: Rules for the LCAO method, bonding and antibonding MOs and their haracteristics or *s-s*, *s-p* and *p-p* combinations of atomic orbitals, nonbonding combination of orbitals, MO treatment of homonuclear diatomic molecules of 1st and 2nd periods (including idea of *s-p* mixing) and heteronuclear diatomic molecules such as CO, NO and NO^+. Comparison of VB and MO approaches.

Section B: Organic Chemistry-1

Fundamentals of Organic Chemistry Dr. Tapas Kumar Adalder (TA)

Physical Effects, Electronic Displacements: Inductive Effect, Electromeric Effect, Resonance

and Hyperconjugation. Cleavage of Bonds: Homolysis and Heterolysis. Structure, shape and reactivity of organic molecules: Nucleophiles and electrophiles. Reactive Intermediates: Carbocations, Carbanions and free radicals. Strength of organic acids and bases: Comparative study with emphasis on factors affecting pK values. Aromaticity: Benzenoids and Hückel's rule.

Stereochemistry Dr. Tapas Kumar Adalder (TA)

Conformations with respect to ethane, butane and cyclohexane. Interconversion of Wedge Formula, Newmann, Sawhorse and Fischer representations. Concept of chirality (upto two carbon atoms). Configuration: Geometrical and Optical isomerism; Enantiomerism, Diastereomerism and Meso compounds). Threo and erythro; D and L; *cis – trans* nomenclature; CIP Rules: R/ S (for upto 2 chiral carbon atoms) and E / Z Nomenclature (for upto two C=C systems).

Aliphatic Hydrocarbons Dr. Prasanta Patra (PP)

Functional group approach for the following reactions (preparations & reactions) to be studied in context to their structure.

Alkanes: (Upto 5 Carbons). *Preparation:* Catalytic hydrogenation, Wurtz reaction, Kolbe's synthesis, from Grignard reagent. *Reactions:* Free radical Substitution: Halogenation.

Alkenes: (Upto 5 Carbons) *Preparation:* Elimination reactions: Dehydration of alkenes and dehydrohalogenation of alkyl halides (Saytzeff's rule); cis alkenes (Partial catalytic hydrogenation) and trans alkenes (Birch reduction). *Reactions:* cis-addition (alk. KMnO4) and trans-addition (bromine), Addition of HX (Markownikoff's and anti-Markownikoff's addition), Hydration, Ozonolysis, oxymecuration-demercuration, Hydroboration-oxidation.

Alkynes: (Upto 5 Carbons) *Preparation:* Acetylene from CaC_2 and conversion into higher alkynes; by dehalogenation of tetra halides and dehydrohalogenation of vicinal-dihalides. *Reactions:* formation of metal acetylides, addition of bromine and alkaline $KMnO_4$, ozonolysis and oxidation with hot alk. $KMnO_4$.

Suggested Readings:

- Lee, J.D. *Concise Inorganic Chemistry* ELBS, 1991.
- Cotton, F.A., Wilkinson, G. & Gaus, P.L. *Basic Inorganic Chemistry*, 3rd ed., Wiley.
- Douglas, B.E., McDaniel, D.H. & Alexander, J.J. *Concepts and Models in Inorganic Chemistry*, John Wiley & Sons.
- Huheey, J.E., Keiter, E.A., Keiter, R.L. & Medhi, O.K. *Inorganic Chemistry: Principles of Structure and Reactivity*, Pearson Education India, 2006.
- Graham Solomon, T.W., Fryhle, C.B. & Dnyder, S.A. *Organic Chemistry*, John Wiley & Sons (2014).
- McMurry, J.E. *Fundamentals of Organic Chemistry*, 7th Ed. Cengage Learning India Edition, 2013.
- Sykes, P. *A Guidebook to Mechanism in Organic Chemistry*, Orient Longman, New Delhi (1988).
- Eliel, E.L. *Stereochemistry of Carbon Compounds*, Tata McGraw Hill education, 2000.
- Finar, I.L. *Organic Chemistry* (Vol. I & II), E.L.B.S.
- Morrison, R.T. & Boyd, R.N. *Organic Chemistry*, Pearson, 2010.
- Bahl, A. & Bahl, B.S. *Advanced Organic Chemistry*, S. Chand, 2010.

DSC1AP: Atomic structure, Bonding, general organic chemistry & aliphatic hydrocarbons (Practical) **Credits 02**

Practical:

Section A: Inorganic Chemistry - Volumetric Analysis
Dr. Tarun Mistri (TM) & Dr. Sanchayita Adikari (SA)

1. Estimation of sodium carbonate and sodium hydrogen carbonate present in a mixture.
2. Estimation of oxalic acid by titrating it with $KMnO_4$.
3. Estimation of water of crystallization in Mohr's salt by titrating with $KMnO_4$.
4. Estimation of Fe (II) ions by titrating it with $K_2Cr_2O_7$ using internal indicator.
5. Estimation of Cu (II) ions iodometrically using $Na_2S_2O_3$.

Section B: Organic Chemistry Dr. Tapas Kumar Adalder (TA) & Dr. Prasanta Patra (PP)

1. Detection of extra elements (N, S, Cl, Br, I) in organic compounds (containing upto two extra elements)
2. Separation of mixtures by Chromatography: Measure the R_f value in each case (combination of two compounds to be given)
   (a) Identify and separate the components of a given mixture of 2 amino acids (glycine, aspartic acid, glutamic acid, tyrosine or any other amino acid) by paper chromatography

   (b) Identify and separate the sugars present in the given mixture by paper chromatography.

Suggested Readings:

- Svehla, G. *Vogel's Qualitative Inorganic Analysis*, Pearson Education, 2012.
- Mendham, J. *Vogel's Quantitative Chemical Analysis*, Pearson, 2009.
- Vogel, A.I., Tatchell, A.R., Furnis, B.S., Hannaford, A.J. & Smith, P.W.G., *Textbook of Practical Organic Chemistry*, Prentice-Hall, 5th edition, 1996.
- Mann, F.G. & Saunders, B.C. *Practical Organic Chemistry* Orient-Longman, 1960.

DSC-1B (CC-2): Chemical Energetics, Equilibria & Functional Organic Chemistry Credits 06

DSC1BT: Chemical Energetics, Equilibria &Functional Organic Chemistry Credits 04

Course Contents:

Section A: Physical Chemistry-1 Dr. Pradipta Ghosh (PG)

Chemical Energetic Dr. Pradipta Ghosh (PG)

Review of thermodynamics and the Laws of Thermodynamics. Important principles and definitions of thermochemistry. Concept of standard state and standard enthalpies of formations, integral and

differential enthalpies of solution and dilution. Calculation of bond energy, bond dissociation energy and resonance energy from thermochemical data. Variation of enthalpy of a reaction with temperature – Kirchhoff's equation. Statement of Third Law of thermodynamics and calculation of absolute entropies of substances.

Chemical Equilibrium: Dr. Pradipta Ghosh (PG)
Free energy change in a chemical reaction. Thermodynamic derivation of the law of chemical equilibrium. Distinction between ΔG and ΔG_o, Le Chatelier's principle. Relationships between K_p, K_c and K_x for reactions involving ideal gases.

Ionic Equilibria: Dr. Pradipta Ghosh (PG)

Strong, moderate and weak electrolytes, degree of ionization, factors affecting degree of ionization, ionization constant and ionic product of water. Ionization of weak acids and bases, pH scale, common ion effect. Salt hydrolysis-calculation of hydrolysis constant, degree of hydrolysis and pH for different salts. Buffer solutions. Solubility and solubility product of sparingly soluble salts – applications of solubility product principle.

Section B: Organic Chemistry-2 Dr. Susovan Mandal (SM)

Functional group approach for the following reactions (preparations & reactions) to be studied in context to their structure.

Aromatic hydrocarbons Dr. Susovan Mandal (SM)
Preparation (Case benzene): from phenol, by decarboxylation, from acetylene, from benzene sulphonic acid.
Reactions: (Case benzene): Electrophilic substitution: nitration, halogenation and sulphonation. Friedel-Craft's reaction (alkylation and acylation) (upto 4 carbons on benzene). Side chain oxidation of alkyl benzenes (upto 4 carbons on benzene).

Alkyl and Aryl Halides Dr. Susovan Mandal (SM)

Alkyl Halides (Upto 5 Carbons) Types of Nucleophilic Substitution (S_N1, S_N2 and S_Ni) reactions. *Preparation:* from alkenes *and* alcohols. *Reactions:* hydrolysis, nitrite & nitro formation, nitrile & isonitrile formation. Williamson's ether synthesis: Elimination vs substitution.

Aryl Halides *Preparation:* (Chloro, bromo and iodo-benzene case): from phenol, Sandmeyer & Gattermann reactions. *Reactions (Chlorobenzene):* Aromatic nucleophilic substitution (replacement by –OH group) and effect of nitro substituent. Benzyne Mechanism: KNH_2/NH_3 (or $NaNH_2/NH_3$). Reactivity and Relative strength of C-Halogen bond in alkyl, allyl, benzyl, vinyl and aryl halides.

Alcohols, Phenols and Ethers (Upto 5 Carbons) Dr. Susovan Mandal (SM)

Alcohols: *Preparation:* Preparation of 1^o, 2^o and 3^o alcohols: using Grignard reagent, Ester hydrolysis, Reduction of aldehydes, ketones, carboxylic acid and esters. *Reactions:* With sodium, HX (Lucas test), esterification, oxidation (with PCC, alk. $KMnO_4$, acidic dichromate, conc. HNO_3). Oppeneauer oxidation *Diols:* (Upto 6 Carbons) oxidation of diols. Pinacol-Pinacolone rearrangement.

Phenols: (Phenol case) *Preparation:* Cumene hydroperoxide method, from diazonium salts.

Reactions: Electrophilic substitution: Nitration, halogenation and sulphonation. Reimer-Tiemann Reaction, Gattermann-Koch Reaction, Houben–Hoesch Condensation, Schotten – Baumann Reaction.

Ethers (aliphatic and aromatic): Cleavage of ethers with HI. Dr. Susovan Mandal (SM)

Aldehydes and ketones (aliphatic and aromatic): (Formaldehye, acetaldehyde, acetone and benzaldehyde) *Preparation:* from acid chlorides and from nitriles. *Reactions* – Reaction with HCN, ROH, $NaHSO_3$, NH_2-G derivatives. Iodoform test. Aldol Condensation, Cannizzaro's reaction, Wittig reaction, Benzoin condensation. Clemensen reduction and Wolff Kishner reduction. Meerwein-Pondorff Verley reduction.

Suggested Readings:

- Graham Solomon, T.W., Fryhle, C.B. & Dnyder, S.A. *Organic Chemistry,* John Wiley & Sons (2014).
- McMurry, J.E. *Fundamentals of Organic Chemistry*, 7th Ed. Cengage Learning India Edition, 2013.
- Sykes, P. *A Guidebook to Mechanism in Organic Chemistry,* Orient Longman, New Delhi (1988).
- Finar, I.L. *Organic Chemistry* (Vol. I & II), E.L.B.S.
- Morrison, R.T. & Boyd, R.N. *Organic Chemistry*, Pearson, 2010.
- Bahl, A. & Bahl, B.S. *Advanced Organic Chemistry,* S. Chand, 2010.
- Barrow, G.M. *Physical Chemistry* Tata McGraw-Hill (2007).
- Castellan, G.W. *Physical Chemistry* 4th Ed. Narosa (2004).
- Kotz, J.C., Treichel, P.M. & Townsend, J.R. *General Chemistry* Cengage Learning India Pvt. Ltd., New Delhi (2009).
- Mahan, B.H. *University Chemistry* 3rd Ed. Narosa (1998).
- Petrucci, R.H. *General Chemistry* 5th Ed. Macmillan Publishing Co.: New York (1985).

DSC1BP: Chemical Energetics, Equilibria & Functional Organic Chemistry (Practical)
Credits 02

Section A: Physical Chemistry Dr. Pradipta Ghosh (PG)

Thermo chemistry:

1. Determination of heat capacity of calorimeter for different volumes.
2. Determination of enthalpy of neutralization of hydrochloric acid with sodium hydroxide.
3. Determination of enthalpy of ionization of acetic acid.
4. Determination of integral enthalpy of solution of salts (KNO_3, NH_4Cl).
5. Determination of enthalpy of hydration of copper sulphate.
6. Study of the solubility of benzoic acid in water and determination of ΔH.

Ionic equilibria:

pH measurements

a) Measurement of pH of different solutions like aerated drinks, fruit juices, shampoos and soaps (use dilute solutions of soaps and shampoos to prevent damage to the glass electrode) using pH-meter.
b) Preparation of buffer solutions:

(i) Sodium acetate-acetic acid
(ii) Ammonium chloride-ammonium hydroxide Measurement of the pH of buffer solutions and comparison of the values with theoretical values.

Section B: Organic Chemistry Dr. Susovan Mandal (SM)

1. Purification of organic compounds by crystallization (from water and alcohol) and distillation.
2. Criteria of Purity: Determination of melting and boiling points.
3. Preparations: Mechanism of various reactions involved to be discussed. Recrystallisation, determination of melting point and calculation of quantitative yields to be done.

(a) Bromination of Phenol/Aniline
(b) Benzoylation of amines/phenols
(c) Oxime and 2,4-dinitrophenylhydrazone of aldehyde/ketone

Suggested Readings:

- Vogel, A.I., Tatchell, A.R., Furnis, B.S., Hannaford, A.J. & Smith, P.W.G., *Textbook of Practical Organic Chemistry*, Prentice-Hall, 5th edition, 1996.
- Mann, F.G. & Saunders, B.C. *Practical Organic Chemistry* Orient-Longman, 1960.
- Khosla, B. D.; Garg, V. C. & Gulati, A. *Senior Practical Physical Chemistry*, R. Chand & Co.: New Delhi (2011).

DSC-1C(CC-3): Solutions, Phase equilibrium, Conductance, Electrochemistry & Functional Organic Chemistry Credits 06

DSC1CT: Solutions, Phase equilibrium, Conductance, Electrochemistry & Functional Organic Chemistry Credits 04

Dr. Nabakumar Bera (NKB), Dr. Pradipta Ghosh (PG) & Dr. Tapas Kumar Adalder (TA)

Course Contents:

Section A: Physical Chemistry-2 Dr. Nabakumar Bera (NKB)

Solutions Dr. Nabakumar Bera (NKB)

Thermodynamics of ideal solutions: Ideal solutions and Raoult's law, deviations from Raoult's law – non-ideal solutions. Vapour pressure-composition and temperature composition curves of ideal and non-ideal solutions. Distillation of solutions. Lever rule. Azeotropes. Partial miscibility of liquids: Critical solution temperature; effect of impurity on partial miscibility of liquids. Immiscibility of liquids- Principle of steam distillation. Nernst distribution law and its applications, solvent extraction.

Phase Equilibrium Dr. Nabakumar Bera (NKB)

Phases, components and degrees of freedom of a system, criteria of phase equilibrium. Gibbs Phase Rule and its thermodynamic derivation. Derivation of Clausius – Clapeyron equation and its importance in phase equilibria. Phase diagrams of one-component systems (water and sulphur) and two component systems involving eutectics, congruent and incongruent melting points (lead-silver, $FeCl_3$-H_2O and Na-K only).

Conductance Dr. Nabakumar Bera (NKB)

Conductivity, equivalent and molar conductivity and their variation with dilution for weak and strong electrolytes. Kohlrausch law of independent migration of ions. Transference number and its experimental determination using Hittorf and Moving boundary methods. Ionic obility. Applications of conductance measurements: determination of degree of ionization of weak electrolyte, solubility and solubility products of sparingly soluble salts, ionic product of water, hydrolysis constant of a salt. Conductometric titrations (only acidbase).

Electrochemistry Dr. Nabakumar Bera (NKB)

Reversible and irreversible cells. Concept of EMF of a cell. Measurement of EMF of a cell. Nernst equation and its importance. Types of electrodes. Standard electrode potential. Electrochemical series. Thermodynamics of a reversible cell, calculation of thermodynamic properties: ΔG, ΔH and ΔS from EMF data. Calculation of equilibrium constant from EMF data. Concentration cells with transference and without transference. Liquid junction potential and salt bridge. pH determination using hydrogen electrode and quinhydrone electrode. Potentiometric titrations -qualitative treatment (acid-base and oxidation-reduction only).

Section B: Organic Chemistry-3 Dr. Tapas Kumar Adalder (TA)

Functional group approach for the following reactions (preparations & reactions) to be studied in context to their structure.

Carboxylic acids and their derivatives Dr. Tapas Kumar Adalder (TA)

Carboxylic acids (aliphatic and aromatic)

Preparation: Acidic and Alkaline hydrolysis of esters. *Reactions:* Hell – Vohlard - Zelinsky Reaction.

Carboxylic acid derivatives (aliphatic): (Upto 5 carbons) Dr. Tapas Kumar Adalder (TA)

Preparation: Acid chlorides, Anhydrides, Esters and Amides from acids and their inter-conversion. *Reactions:* Comparative study of nucleophilicity of acyl derivatives. Reformatsky Reaction, Perkin condensation.

Amines and Diazonium Salts Dr. Tapas Kumar Adalder (TA)

Amines (Aliphatic and Aromatic): (Upto 5 carbons)

Preparation: from alkyl halides, Gabriel's Phthalimide synthesis, Hofmann Bromamide reaction. *Reactions:* Hofmann vs. Saytzeff elimination, Carbylamine test, Hinsberg test, with HNO_2, Schotten – Baumann Reaction. Electrophilic substitution (case aniline): nitration, bromination, sulphonation.

Diazonium salts: *Preparation:* from aromatic amines.*Reactions:* conversion to benzene, phenol, dyes.

Amino Acids, Peptides and Proteins: Dr. Tapas Kumar Adalder (TA)

Preparation of Amino Acids: Strecker synthesis using Gabriel's phthalimide synthesis. Zwitterion, Isoelectric point and Electrophoresis. *Reactions of Amino acids*: ester of – COOH group, acetylation of $–NH_2$ group, complexation with Cu^{2+} ions, ninhydrin test. Overview of Primary, Secondary, Tertiary and Quaternary Structure of proteins. Determination of Primary structure of Peptides by degradation Edmann degradation (Nterminal) and C–terminal (thiohydantoin and with carboxypeptidase enzyme). Synthesis of simple peptides (upto dipeptides) by N-protection (t-butyloxycarbonyl and phthaloyl) & Cactivating groups and Merrifield solid-phase synthesis.

Carbohydrates: Dr. Tapas Kumar Adalder (TA)

Classification, and General Properties, Glucose and Fructose (open chain and cyclic structure), Determination of configuration of monosaccharides, absolute configuration of Glucose and Fructose, Mutarotation, ascending and descending in monosaccharides. Structure of disacharrides (sucrose, cellobiose, maltose, lactose) and polysacharrides (starch and cellulose) excluding their structure elucidation.

Suggested Readings:

- Barrow, G.M. *Physical Chemistry* Tata McGraw-Hill (2007).
- Castellan, G.W. *Physical Chemistry* 4th Ed. Narosa (2004).
- Kotz, J.C., Treichel, P.M. & Townsend, J.R. *General Chemistry*, Cengage Learning India Pvt. Ltd.: New Delhi (2009).
- Mahan, B.H. *University Chemistry*, 3rd Ed. Narosa (1998).
- Petrucci, R.H. *General Chemistry*, 5th Ed., Macmillan Publishing Co.: New York (1985).
- Morrison, R. T. & Boyd, R. N. *Organic Chemistry*, Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).
- Finar, I. L. *Organic Chemistry* (*Volume 1*), Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).
- Finar, I. L. *Organic Chemistry* (*Volume 2)*, Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).
- Nelson, D. L. & Cox, M. M. *Lehninger's Principles of Biochemistry 7th Ed.*, W. H. Freeman.
- Berg, J.M., Tymoczko, J.L. & Stryer, L. *Biochemistry*, W.H. Freeman, 2002.

DSC-1CP: Solutions, Phase Equilibrium, Conductance, Electrochemistry & Functional Organic Chemistry (Practical) Credits 02

Practical:

Section A: Physical Chemistry Dr. Nabakumar Bera (NKB)

Distribution Dr. Nabakumar Bera (NKB)

Study of the equilibrium of one of the following reactions by the distribution method:

$I_2(aq) + I^-(aq) \rightleftharpoons I_3^-(aq)$
$Cu^{2+}(aq) + xNH_2(aq) \rightleftharpoons [Cu(NH_3)_x]^{2+}$

Phase equilibria Dr. Nabakumar Bera (NKB)

a) Construction of the phase diagram of a binary system (simple eutectic) using cooling curves.
b) Determination of the critical solution temperature and composition of the phenol water system and study of the effect of impurities on it.
c) Study of the variation of mutual solubility temperature with concentration for the phenol water system and determination of the critical solubility temperature.

Conductance Dr. Pradipta Ghosh (PG)

I. Determination of cell constant
II. Determination of equivalent conductance, degree of dissociation and dissociation constant of a weak acid.
III. Perform the following conductometric titrations:

i. Strong acid vs. strong base
ii. Weak acid vs. strong base

Potentiometry Dr. Pradipta Ghosh (PG)

Perform the following potentiometric titrations:
i. Strong acid vs. strong base
ii. Weak acid vs. strong base
iii. Potassium dichromate vs. Mohr's salt

Section B: Organic Chemistry Dr. Tapas Kumar Adalder (TA)

I Systematic Qualitative Organic Analysis of Organic Compounds possessing monofunctional groups (-COOH, phenolic, aldehydic, ketonic, amide, nitro, amines) and preparation of one derivative.

II

1. Separation of amino acids by paper chromatography
2. Determination of the concentration of glycine solution by formylation method.
3. Titration curve of glycine
4. Action of salivary amylase on starch
5. Effect of temperature on the action of salivary amylase on starch.
6. Differentiation between a reducing and a nonreducing sugar.

Suggested Readings:

- Vogel, A.I., Tatchell, A.R., Furnis, B.S., Hannaford, A.J. & Smith, P.W.G., *Textbook of Practical Organic Chemistry*, Prentice-Hall, 5th edition, 1996.
- Mann, F.G. & Saunders, B.C. *Practical Organic Chemistry* Orient-Longman, 1960.
- Khosla, B. D.; Garg, V. C. & Gulati, A. *Senior Practical Physical Chemistry*, R. Chand & Co.: New Delhi (2011).
- Ahluwalia, V.K. & Aggarwal, R. *Comprehensive Practical Organic Chemistry*, Universities Press.

DSC-1D(CC-4):Coordination Chemistry, States of matter Chemical Kinetics
Credits 06

DSC1DT: Coordination Chemistry, States of matter Chemical Kinetics
Credits 04

Dr. Tarun Mistri (TM) & Dr. Pradipta Ghosh (PG)

Course Contents:

Transition Elements (3d series) Dr. Tarun Mistri (TM)

General group trends with special reference to electronic configuration, variable valency, colour, magnetic and catalytic properties, ability to form complexes and stability of various oxidation states (Latimer diagrams) for Mn, Fe and Cu. Lanthanoids and actinoids: Electronic configurations, oxidation states, colour, magnetic properties, lanthanide contraction, separation of lanthanides (ion exchange method only).

Coordination Chemistry Dr. Tarun Mistri (TM)

Valence Bond Theory (VBT): Inner and outer orbital complexes of Cr, Fe, Co, Ni and Cu (coordination numbers 4 and 6). Structural and stereoisomerism in complexes with coordination numbers 4 and 6. Drawbacks of VBT. IUPAC system of nomenclature.

Crystal Field Theory Dr. Tarun Mistri (TM)

Crystal field effect, octahedral symmetry. Crystal field stabilization energy (CFSE), Crystal field effects for weak and strong fields. Tetrahedral symmetry. Factors affecting the magnitude of D. Spectrochemical series. Comparison of CFSE for O_h and T_d complexes, Tetragonal distortion of octahedral geometry. Jahn-Teller distortion, Square planar coordination.

Section B: Physical Chemistry-3

Kinetic Theory of Gases Dr. Pradipta Ghosh (PG)

Postulates of Kinetic Theory of Gases and derivation of the kinetic gas equation. Deviation of real gases from ideal behaviour, compressibility factor, causes of deviation. Van der Waals equation of state for real gases. Boyle temperature (derivation not required). Critical phenomena, critical constants and their calculation from van der Waals equation. Andrews isotherms of CO_2. Maxwell Boltzmann distribution laws of molecular velocities and molecular energies (graphic representation – derivation not required) and their importance. Temperature dependence of these distributions. Most probable, average and root mean square velocities (no derivation). Collision cross section, collision number, collision frequency, collision diameter and mean free path of molecules. Viscosity of gases and effect of temperature and pressure on coefficient of viscosity (qualitative treatment only).

Liquids Dr. Pradipta Ghosh (PG)

Surface tension and its determination using stalagmometer. Viscosity of a liquid and determination of coefficient of viscosity using Ostwald viscometer. Effect of temperature on surface tension and coefficient of viscosity of a liquid (qualitative treatment only).

Solids Dr. Pradipta Ghosh (PG)

Forms of solids. Symmetry elements, unit cells, crystal systems, Bravais lattice types and identification of lattice planes. Laws of Crystallography - Law of constancy of interfacial angles, Law of rational indices. Miller indices. X–Ray diffraction by crystals, Bragg's law. Structures of NaCl, KCl and CsCl (qualitative treatment only). Defects in crystals. Glasses and liquid crystals.

Chemical Kinetics Dr. Pradipta Ghosh (PG)

The concept of reaction rates. Effect of temperature, pressure, catalyst and other factors on reaction rates. Order and molecularity of a reaction. Derivation of integrated rate equations for zero, first and second order reactions (both for equal and unequal concentrations of reactants). Half–life of a reaction. General methods for determination of order of a reaction. Concept of activation energy and its calculation from Arrhenius equation.
Theories of Reaction Rates: Collision theory and Activated Complex theory of bimolecular reactions. Comparison of the two theories (qualitative treatment only).

Suggested Readings:

- Barrow, G.M. *Physical Chemistry* Tata McGraw-Hill (2007).
- Castellan, G.W. *Physical Chemistry* 4th Ed. Narosa (2004).
- Kotz, J.C., Treichel, P.M. & Townsend, J.R. *General Chemistry* Cengage Learning India Pvt. Ltd., New Delhi (2009).
- Mahan, B.H. *University Chemistry* 3rd Ed. Narosa (1998).
- Petrucci, R.H. *General Chemistry* 5th Ed. Macmillan Publishing Co.: New York (1985).
- Cotton, F.A. & Wilkinson, G. *Basic Inorganic Chemistry*, Wiley.
- Shriver, D.F. & Atkins, P.W. *Inorganic Chemistry*, Oxford University Press.
- Wulfsberg, G. *Inorganic Chemistry*, Viva Books Pvt. Ltd.
- Rodgers, G.E. *Inorganic & Solid State Chemistry*, Cengage Learning India Ltd., 2008.

DSC1DP: Coordination Chemistry, States of matter & Chemical Kinetics (Practical)

Credits 02

Practical:

Section A: Inorganic Chemistry Dr. Tarun Mistri (TM)

Semi-micro qualitative analysis using H_2S of mixtures - not more than four ionic species (two anions and two cations and excluding insoluble salts) out of the following:

Cations : NH^{4+}, Pb^{2+}, Ag^{2+}, Bi^{3+}, Cu^{2+}, Cd^{2+}, Sn^{2+}, Fe^{3+}, Al^{3+}, Co^{2+}, Cr^{3+}, Ni^{2+}, Mn^{2+}, Zn^{2+}, Ba^{2+}, Sr^{2+}, Ca^{2+}, K^{+}

Anions : CO_3^{2-}, S^{2-}, SO^{2-}, $S_2O_3^{2-}$, NO_3^{-}, CH_3COO^{-}, Cl^{-}, Br^{-}, I^{-}, NO_3^{-},SO_4^{2-}, PO_4^{3-}, BO_3^{3-}, $C_2O_4^{2-}$, F^{-}

(Spot tests should be carried out wherever feasible)

1. Estimate the amount of nickel present in a given solution as bis (dimethylglyoximato) nickel(II) or aluminium as oximate in a given solution gravimetrically.
2. Draw calibration curve (absorbance at λ_{max} vs. concentration) for various concentrations of a given coloured compound ($KMnO_4$/ $CuSO_4$) and estimate the concentration of the same in a given solution.
3. Determine the composition of the Fe^{3+}-salicylic acid complex solution by Job's method.
4. Estimation of (i) Mg^{2+} or (ii) Zn^{2+} by complexometric titrations using EDTA.
5. Estimation of total hardness of a given sample of water by complexometric titration.
6. Determination of concentration of Na^+ and K^+ using Flame Photometry.

Section B: Physical Chemistry Dr. Pradipta Ghosh (PG)

(I) Surface tension measurement (use of organic solvents excluded).

a) Determination of the surface tension of a liquid or a dilute solution using a stalagmometer.
c) Study of the variation of surface tension of a detergent solution with concentration.

(II) Viscosity measurement (use of organic solvents excluded).
a) Determination of the relative and absolute viscosity of a liquid or dilute solution using an Ostwald's viscometer.
b) Study of the variation of viscosity of an aqueous solution with concentration of solute.

(III) Chemical Kinetics

Study the kinetics of the following reactions.
1. Initial rate method: Iodide-persulphate reaction
2. Integrated rate method:
   a. Acid hydrolysis of methyl acetate with hydrochloric acid.
   b. Saponification of ethyl acetate.
   c. Compare the strengths of HCl and H_2SO_4 by studying kinetics of hydrolysis of methyl acetate

Suggested Readings:

- Svehla, G. *Vogel's Qualitative Inorganic Analysis*, Pearson Education, 2012.
- Mendham, J. *Vogel's Quantitative Chemical Analysis*, Pearson, 2009.
- Khosla, B. D.; Garg, V. C. & Gulati, A. *Senior Practical Physical Chemistry*, R.
- Chand & Co.: New Delhi (2011).

Discipline Specific Electives (DSE)

DSE-1: Analytical Methods in Chemistry — Credits 06

DSE1T: Analytical Methods in Chemistry — Credits 04

Course Contents:

Qualitative and quantitative aspects of analysis:

Sampling, evaluation of analytical data, errors, accuracy and precision, methods of their expression, normal law of distribution if indeterminate errors, statistical test of data; F, Q and t test, rejection of data, and confidence intervals.

Optical methods of analysis:

Origin of spectra, interaction of radiation with matter, fundamental laws of spectroscopy and selection rules, validity of Beer-Lambert's law.

UV-Visible Spectrometry: Basic principles of instrumentation (choice of source, monochromator and detector) for single and double beam instrument; *Basic principles of quantitative analysis:* estimation of metal ions from aqueous solution, geometrical isomers, keto -enol tautomers. Determination of composition of metal complexes using Job's method of continuous variation and mole ratio method.

Infrared Spectrometry: Basic principles of instrumentation (choice of source, monochromator & detector) for single and double beam instrument; sampling techniques. Structural illustration through interpretation of data, Effect and importance of isotope substitution.

Flame Atomic Absorption and Emission Spectrometry: Basic principles of instrumentation (choice of source, monochromator, detector, choice of flame and Burner designs. Techniques of atomization and sample introduction; Method of background correction, sources of chemical interferences and their method of removal. Techniques for the quantitative estimation of trace level of metal ions from water samples.

Thermal methods of analysis:

Theory of thermogravimetry (TG), basic principle of instrumentation. Techniques for quantitative estimation of Ca and Mg from their mixture.

Electro-analytical methods:

Classification of electroanalytical methods, basic principle of pH metric, potentiometric and conductometric titrations. Techniques used for the determination of equivalence points. Techniques used for the determination of pK_a values.

Separation techniques:

Solvent extraction: Classification, principle and efficiency of the technique. Mechanism of extraction: extraction by solvation and chelation. **Technique of extraction:** batch, continuous and counter current extractions. **Qualitative and quantitative aspects of solvent extraction:** extraction of metal ions from aqueous solution, extraction of organic species from the aqueous and nonaqueous media. **Chromatography:** Classification, principle and efficiency of the technique. Mechanism of separation: adsorption, partition & ion exchange. **Development of chromatograms:** frontal, elution and displacement methods. Qualitative and quantitative aspects of chromatographic methods of analysis: IC, GLC, GPC, TLC and HPLC. **Stereoisomeric separation and analysis:** Measurement of optical rotation, calculation of Enantiomeric excess (ee)/ diastereomeric excess (de) ratios and determination of enantiomeric composition using NMR, Chiral solvents and chiral shift reagents.

Chiral chromatographic techniques using chiral columns (GC and HPLC). Role of computers in instrumental methods of analysis.

Suggested Readings:

- Jeffery, G.H., Bassett, J., Mendham, J. & Denney, R.C. *Vogel's Textbook of Quantitative Chemical Analysis*, John Wiley & Sons.
- Willard, H.H., Merritt, L.L., Dean, J. & Settoe, F.A. *Instrumental Methods of Analysis*, 7th Ed. Wadsworth Publishing Company Ltd., Belmont, California, USA,
- Christian, G.D; *Analytical Chemistry*, 6th Ed. John Wiley & Sons, New York.
- Harris, D. C. *Exploring Chemical Analysis*, Ed. New York, W.H. Freeman.
- Khopkar, S.M. *Basic Concepts of Analytical Chemistry*. New Age, International Publisher.
- Skoog, D.A. Holler F.J. & Nieman, T.A. *Principles of Instrumental Analysis*, Cengage Learning India Ed.
- Mikes, O. *Laboratory Hand Book of Chromatographic & Allied Methods*, Elles Harwood Series on Analytical Chemistry, John Wiley & Sons.
- Ditts, R.V. *Analytical Chemistry; Methods of Separation*, van Nostrand.

DSE1P: Analytical methods in Chemistry (Lab) **Credits 02**

I. Separation Techniques

1. Chromatography:
   (a) Separation of mixtures
      (i) Paper chromatographic separation of Fe^{3+} Al^{3+}, and Cr^{3+}.
      (ii) Separation and identification of the monosaccharide present in the given mixture (glucose & fructose) by paper chromatography. Reporting the R_f values.
   (b) Separate a mixture of Sudan yellow and Sudan Red by TLC technique and identify them on the basis of their R_f values.
   (c) Chromatographic separation of the active ingredients of plants, flowers and juices by TLC

II. Solvent Extractions:

1. To separate a mixture of Ni^{2+} & Fe^{2+} by complexation with DMG and extracting the Ni^{2+}-DMG complex in chloroform, and determine its concentration by spectrophotometry.
2. Solvent extraction of zisconium with amberliti LA-1, separation from a mixture of irons and gallium.
3. Determine the pH of the given aerated drinks fruit juices, shampoos and soaps.
4. Determination of Na, Ca, Li in cola drinks and fruit juices using flame photometric techniques.
5. Analysis of soil:
   1. Determination of pH of soil.
   2. Total soluble salt
   3. Estimation of calcium, magnesium, phosphate, nitrate
6. Ion exchange:
   i. Determination of exchange capacity of cation exchange resins and anion exchange resins.
   ii. Separation of metal ions from their binary mixture.

iii. Separation of amino acids from organic acids by ion exchange chromatography.

III Spectrophotometry

1. Determination of pK_a values of indicator using spectrophotometry.
2 Structural characterization of compounds by infrared spectroscopy.
3 Determination of dissolved oxygen in water.
4 Determination of chemical oxygen demand (COD).
5 Determination of Biological oxygen demand (BOD).
6 Determine the composition of the Ferric-salicylate / Ferric-thiocyanate complex by Job's method.

Suggested Readings:

- Jeffery, G.H., Bassett, J., Mendham, J. & Denney, R.C. *Vogel's Textbook of Quantitative Chemical Analysis*, John Wiley & Sons.
- Willard, H.H., Merritt, L.L., Dean, J. & Settoe, F.A. *Instrumental Methods of Analysis*, 7th Ed. Wadsworth Publishing Company Ltd., Belmont, California, USA.
- Christian, Gary D; Analytical Chemistry, 6th Ed. John Wiley & Sons, New York.
- Harris, Daniel C: Exploring Chemical Analysis, Ed. New York, W.H. Freeman.
- Khopkar, S.M. Basic Concepts of Analytical Chemistry. New Age, International Publisher.
- Skoog, D.A. Holler F.J. & Nieman, T.A. *Principles of Instrumental Analysis*, Cengage Learning India Ed.
- Mikes, O. *Laboratory Hand Book of Chromatographic & Allied Methods*, Elles Harwood Series on Analytical Chemistry, John Wiley & Sons.
- Ditts, R.V. *Analytical Chemistry; Methods of Separation*, van Nostrand.

Or

DSE-1: Polymer Chemistry — Credits 06

DSE1T: Polymer Chemistry — Credits 04

Course Contents:

Introduction and history of polymeric materials:

Different schemes of classification of polymers, Polymer nomenclature, Molecular forces and chemical bonding in polymers, Texture of Polymers.

Functionality and its importance:

Criteria for synthetic polymer formation, classification of polymerization processes, Relationships between functionality, extent of reaction and degree of polymerization. Bifunctional systems, Poly-functional systems.

Kinetics of Polymerization:

Mechanism and kinetics of step growth, radical chain growth, ionic chain (both cationic and anionic) and coordination polymerizations, Mechanism and kinetics of copolymerization, polymerization techniques.

Crystallization and crystallinity:

Determination of crystalline melting point and degree of crystallinity, Morphology of crystalline polymers, Factors affecting crystalline melting point.

Nature and structure of polymers - Structure Property relationships.

Determination of molecular weight of polymers (M_n, M_w, etc) by end group analysis, viscometry, light scattering and osmotic pressure methods. Molecular weight distribution and its significance. Polydispersity index.

Glass transition temperature (Tg) and determination of Tg, Free volume theory, WLF equation, Factors affecting glass transition temperature (Tg).

Polymer Solution – Criteria for polymer solubility, Solubility parameter, Thermodynamics of polymer solutions, entropy, enthalpy, and free energy change of mixing of polymers olutions, Flory-Huggins theory, Lower and Upper critical solution temperatures.

Properties of Polymers (Physical, thermal, Flow & Mechanical Properties).

Brief introduction to preparation, structure, properties and application of the following polymers: polyolefins, polystyrene and styrene copolymers, poly(vinyl chloride) and related polymers, poly(vinyl acetate) and related polymers, acrylic polymers, fluoro polymers, polyamides and related polymers. Phenol formaldehyde resins (Bakelite, Novalac), polyurethanes, silicone polymers, polydienes, Polycarbonates, Conducting Polymers, [polyacetylene, polyaniline, poly(p-phenylene sulphide polypyrrole, polythiophene)].

Suggested Readings:

- Seymour, R.B. & Carraher, C.E. *Polymer Chemistry: An Introduction,* Marcel Dekker, Inc. New York, 1981.
- Odian, G. *Principles of Polymerization*, 4th Ed. Wiley, 2004.
- Billmeyer, F.W. *Textbook of Polymer Science*, 2nd Ed. Wiley Interscience, 1971.
- Ghosh, P. *Polymer Science & Technology*, Tata McGraw-Hill Education, 1991.
- Lenz, R.W. *Organic Chemistry of Synthetic High Polymers.* Interscience Publishers, New York, 1967.

DSE1P: Polymer Chemistry (Lab) **Credits 02**

Practical:

1. **Polymer synthesis**
    1. Free radical solution polymerization of styrene (St) / Methyl Methacrylate (MMA) Methyl Acrylate (MA) / Acrylic acid (AA).
        a. Purification of monomer
        b. Polymerization using benzoyl peroxide (BPO) / 2,2'-azo-bis-isobutylonitrile (AIBN)

2. Preparation of nylon 66/6
3. Interfacial polymerization, preparation of polyester from isophthaloyl chloride (IPC) and phenolphthalein
    a. Preparation of IPC
    b. Purification of IPC
    c. Interfacial polymerization
4. Redox polymerization of acrylamide
5. Precipitation polymerization of acrylonitrile
6. Preparation of urea-formaldehyde resin
7. Preparations of novalac resin/resold resin.
8. Microscale Emulsion Polymerization of Poly(methylacrylate).

Polymer characterization

1. Determination of molecular weight by viscometry:
   (a) Polyacrylamide-aq.$NaNO_2$ solution
   (b) (Poly vinyl proplylidine (PVP) in water
2. Determination of the viscosity-average molecular weight of poly(vinyl alcohol) (PVOH) and the fraction of "head-to-head" monomer linkages in the polymer.
3. Determination of molecular weight by end group analysis: Polyethylene glycol (PEG)(OH group).
4. Testing of mechanical properties of polymers.
5. Determination of hydroxyl number of a polymer using colorimetric method.

Polymer analysis

1. Estimation of the amount of HCHO in the given solution by sodium sulphite method
2. Instrumental Techniques
3. IR studies of polymers
4. DSC analysis of polymers
5. Preparation of polyacrylamide and its electrophoresis

*at least 7 experiments to be carried out.

Suggested Readings:

- M.P. Stevens, *Polymer Chemistry: An Introduction*, 3rd Ed., Oxford University Press, 1999.
- H.R. Allcock, F.W. Lampe & J.E. Mark, *Contemporary Polymer Chemistry*, 3rd ed. Prentice-Hall (2003)
- F.W. Billmeyer, *Textbook of Polymer Science*, 3rd ed. Wiley-Interscience (1984)
- J.R. Fried, *Polymer Science and Technology*, 2nd ed. Prentice-Hall (2003)
- P. Munk & T.M. Aminabhavi, *Introduction to Macromolecular Science*, 2nd ed. John Wiley & Sons (2002)
- L. H. Sperling, *Introduction to Physical Polymer Science*, 4th ed. John Wiley & Sons (2005)
- M.P. Stevens, *Polymer Chemistry: An Introduction* 3rd ed. Oxford University Press (2005).
- Seymour/ Carraher's Polymer Chemistry, 9th ed. by Charles E. Carraher, Jr. (2013).

Or

DSE-1: Instrumental Methods of Chemical Analysis Credits 06

DSE1T: Instrumental Methods of Chemical Analysis Credits 04

Course Contents:

Introduction to spectroscopic methods of analysis:

Recap of the spectroscopic methods covered in detail in the core chemistry syllabus: Treatment of analytical data, including error analysis. Classification of analytical methods and the types of instrumental methods. Consideration of electromagnetic radiation.

Molecular spectroscopy:

Infrared spectroscopy:

Interactions with molecules: absorption and scattering. Means of excitation (light sources), separation of spectrum (wavelength dispersion, time resolution), detection of the signal (heat, differential detection), interpretation of spectrum (qualitative, mixtures, resolution),advantages of Fourier Transform (FTIR). Samples and results expected. Applications: Issues of quality assurance and quality control, Special problems for portable instrumentation and rapid detection.

UV-Visible/ Near IR – emission, absorption, fluorescence and photoaccoustic. Excitation sources (lasers, time resolution), wavelength dispersion (gratings, prisms, interference filters, laser, placement of sample relative to dispersion, resolution), Detection of signal (photocells, photomultipliers, diode arrays, sensitivity and S/N), Single and Double Beam instruments, Interpretation (quantification, mixtures, absorption vs. fluorescence and the use of time, photoaccoustic, fluorescent tags).

Separation techniques

Chromatography: Gas chromatography, liquid chromatography, supercritical fluids, Importance of column technology (packing, capillaries), Separation based on increasing number of factors (volatility, solubility, interactions with stationary phase, size, electrical field), Detection: simple vs. specific (gas and liquid), Detection as a means of further analysis (use of tags and coupling to IR and MS), Electrophoresis (plates and capillary) and use with DNA analysis. Immunoassays and DNA techniques

Mass spectroscopy: Making the gaseous molecule into an ion (electron impact, chemical ionization), Making liquids and solids into ions (electrospray, electrical discharge, laser desorption, fast atom bombardment), Separation of ions on basis of mass to charge ratio, Magnetic, Time of flight, Electric quadrupole. Resolution, time and multiple separations, Detection and interpretation (how this is linked to excitation).

Elemental analysis:

Mass spectrometry (electrical discharges).
Atomic spectroscopy: Atomic absorption, Atomic emission, and Atomic fluorescence. Excitation and getting sample into gas phase (flames, electrical discharges, plasmas), Wavelength separation and resolution (dependence on technique), Detection of radiation (simultaneous/scanning, signal noise), Interpretation (errors due to molecular and ionic species, matrix effects, other interferences).

NMR spectroscopy: **P**rinciple, Instrumentation, Factors affecting chemical shift, Spin coupling, Applications.

Electro analytical Methods: Potentiometry & Voltammetry

Radiochemical Methods.

X-ray analysis and electron spectroscopy (surface analysis).

Suggested Readings:

- Skoog, D.A. Holler F.J. & Nieman, T.A. *Principles of Instrumental Analysis*, Cengage Learning India Ed.
- Willard, H.H., Merritt, L.L., Dean, J. & Settoe, F.A. *Instrumental Methods of Analysis*, 7th Ed. Wadsworth Publishing Company Ltd., Belmont, California, USA, 1988.
- P.W. Atkins: Physical Chemistry.
- G.W. Castellan: Physical Chemistry.
- C.N. Banwell: Fundamentals of Molecular Spectroscopy.
- Brian Smith: Infrared Spectral Interpretations: A Systematic Approach.
- W.J. Moore: Physical Chemistry.

DSE1P: Instrumental Methods of Chemical Analysis (Lab) Credits 02

Practical:

1. Safety Practices in the Chemistry Laboratory
2. Determination of the isoelectric pH of a protein.
3. Titration curve of an amino acid.
4. Determination of the void volume of a gel filtration column.
5. Determination of a Mixture of Cobalt and Nickel (UV/Vis spec.)
6. Study of Electronic Transitions in Organic Molecules (i.e., acetone in water)
7. IR Absorption Spectra (Study of Aldehydes and Ketones)
8. Determination of Calcium, Iron, and Copper in Food by Atomic Absorption
9. Quantitative Analysis of Mixtures by Gas Chromatography (i.e., chloroform and carbon tetrachloride)
10. Separation of Carbohydrates by HPLC
11. Determination of Caffeine in Beverages by HPLC
12. Potentiometric Titration of a Chloride-Iodide Mixture
13. Cyclic Voltammetry of the Ferrocyanide/Ferricyanide Couple
14. Nuclear Magnetic Resonance
15. Use of fluorescence to do “presumptive tests” to identify blood or other body fluids.
16. Use of “presumptive tests” for anthrax or cocaine
17. Collection, preservation, and control of blood evidence being used for DNA testing
18. Use of capillary electrophoresis with laser fluorescence detection for nuclear DNA (Y chromosome only or multiple chromosomes)
19. Use of sequencing for the analysis of mitochondrial DNA
20. Laboratory analysis to confirm anthrax or cocaine
21. Detection in the field and confirmation in the laboratory of flammable accelerants or explosives
22. Detection of illegal drugs or steroids in athletes
23. Detection of pollutants or illegal dumping
24. Fibre analysis

At least 10 experiments to be performed.

Suggested Readings:

- Skoog, D.A. Holler F.J. & Nieman, T.A. *Principles of Instrumental Analysis*, Cengage Learning India Ed.

- Willard, H.H., Merritt, L.L., Dean, J. & Settoe, F.A. *Instrumental Methods of Analysis*, 7th Ed. Wadsworth Publishing Company Ltd., Belmont, California, USA, 1988.

Or

DSE-1: Organometallics, Bioinorganic Chemistry, Polynuclear hydrocarbons and UV, IR Spectroscopy

Credits 06

DSE1T: Organometallics, Bioinorganic Chemistry, Polynuclear hydrocarbons and UV, IR Spectroscopy **Credits 04**

Course Contents:

Section A: Inorganic Chemistry-4

Chemistry of 3d metals

Oxidation states displayed by Cr, Fe, Co, Ni and Co. A study of the following compounds (including preparation and important properties); Peroxo compounds of Cr, $K_2Cr_2O_7$, $KMnO_4$, $K_4[Fe(CN)_6]$, sodium nitroprusside $[Co(NH_3)_6]Cl_3$, $Na_3[Co(NO_2)_6]$.

Organometallic Compounds

Definition and Classification with appropriate examples based on nature of metal-carbon bond (ionic, s, p and multicentre bonds). Structures of methyl lithium, Zeiss salt and ferrocene. AN rule as applied to carbonyls. Preparation, structure, bonding and properties of mononuclear and polynuclear carbonyls of 3d metals. p-acceptor behaviour of carbon monoxide. Synergic effects (VB approach)-(MO diagram of CO can be referred to for synergic effect to IR frequencies).

Bio-inorganic Chemistry

A brief introduction to bio-inorganic chemistry. Role of metal ions present in biological systems with special reference to Na^+, K^+ and Mg^{2+} ions: Na/K pump; Role of Mg^{2+} ions in energy production and chlorophyll. Role of Ca^{2+} in blood clotting, stabilization of protein structures and structural role (bones).

Section B: Organic Chemistry - 4

Polynuclear and heteronuclear aromatic compounds:

Properties of the following compounds with reference to electrophilic and nucleophilic substitution: Naphthalene, Anthracene , Furan, Pyrrole, Thiophene, and Pyridine.

Active methylene compounds:

Preparation: Claisen ester condensation. Keto-enol tautomerism. *Reactions:* Synthetic uses of ethylacetoacetate (preparation of non-heteromolecules having upto 6 carbon).

Application of Spectroscopy to Simple Organic Molecules

Application of visible, ultraviolet and Infrared spectroscopy in organic molecules. Electromagnetic radiations, electronic transitions, λ_{max} & ε_{max}, chromophore, auxochrome, bathochromic and hypsochromic shifts. Application of electronic spectroscopy and Woodward rules for calculating l max of conjugated dienes and α,β – unsaturated Compounds.

Infrared radiation and types of molecular vibrations, functional group and fingerprint region. IR spectra of alkanes, alkenes and simple alcohols (inter and intramolecular hydrogen bonding), aldehydes, ketones, carboxylic acids and their derivatives (effect of substitution on >C=O stretching absorptions).

Suggested Readings:

- James E. Huheey, Ellen Keiter & Richard Keiter: *Inorganic Chemistry: Principles of Structure and Reactivity,* Pearson Publication.
- G.L. Miessler & Donald A. Tarr: *Inorganic Chemistry*, Pearson Publication.
- J.D. Lee: *A New Concise Inorganic Chemistry*, E.L.B.S.
- F.A. Cotton & G. Wilkinson: *Basic Inorganic Chemistry*, John Wiley & Sons.
- I.L. Finar: *Organic Chemistry* (Vol. I & II), E.L.B.S.
- John R. Dyer: *Applications of Absorption Spectroscopy of Organic Compounds*, Prentice Hall.
- R.M. Silverstein, G.C. Bassler & T.C. Morrill*: Spectroscopic Identification of*
- *Organic Compounds*, John Wiley & Sons.
- R.T. Morrison & R.N. Boyd: *Organic Chemistry*, Prentice Hall.
- Peter Sykes: *A Guide Book to Mechanism* in *Organic Chemistry*, Orient Longman.
- Arun Bahl and B. S. Bahl: *Advanced Organic Chemistry*, S. Chand.

DSE-1P: Practical **Credits 02**

Practical:

Section A: Inorganic Chemistry

1. Separation of mixtures by chromatography: Measure the R_f value in each case. (Combination of two ions to be given) Paper chromatographic separation of Fe^{3+}, $A1^{3+}$ and Cr^{3+} or Paper chromatographic separation of Ni^{2+}, Co^{2+}, Mn^{2+} and Zn^{2+}
2. Preparation of any two of the following complexes and measurement of their conductivity:
   (i) tetraamminecarbonatocobalt (III) nitrate
   (ii) tetraamminecopper (II) sulphate
   (iii) potassium trioxalatoferrate (III) trihydrate

Compare the conductance of the complexes with that of M/1000 solution of NaCl, $MgCl_2$ and

$LiCl_3$.

Section B: Organic Chemistry

Systematic Qualitative Organic Analysis of Organic Compounds possessing monofunctional groups (-COOH, phenolic, aldehydic, ketonic, amide, nitro, amines) and preparation of one derivative.

Suggested Readings:

- A.I. Vogel: Qualitative Inorganic Analysis, Prentice Hall, 7th Edn.
- A.I. Vogel: Quantitative Chemical Analysis, Prentice Hall, 6th Edn.
- Vogel, A.I., Tatchell, A.R., Furnis, B.S., Hannaford, A.J. & Smith, P.W.G., *Textbook of Practical Organic Chemistry*, Prentice-Hall, 5th edition, 1996.
- Mann, F.G. & Saunders, B.C. *Practical Organic Chemistry* Orient-Longman, 1960.

DSE-2: Applications of computers in chemistry Credits 06

DSE2T: Applications of computers in chemistry Credits 04

Course Contents:

Basics:

Constants, variables, bits, bytes, binary and ASCII formats, arithmetic expressions, hierarchy of operations, inbuilt functions. Elements of the BASIC language. BASIC keywords and commands. Logical and relative operators. Strings and graphics. Compiled versus interpreted languages. Debugging. Simple programs using these concepts. Matrix addition and multiplication. Statistical analysis.

Numerical methods:

Roots of equations: Numerical methods for roots of equations: Quadratic formula, iterative method, Newton-Raphson method, Binary bisection and Regula-Falsi. *Differential calculus:* Numerical differentiation. *Integral calculus:* Numerical integration (Trapezoidal and Simpson's rule), probability distributions and mean values. *Simultaneous equations:* Matrix manipulation: addition, multiplication. Gauss-Siedal method. *Interpolation, extrapolation and curve fitting:* Handling of experimental data. *Conceptual background of molecular modelling:* Potential energy surfaces. Elementary idea of molecular mechanics and practical MO methods.

Suggested Readings:

- Harris, D. C. *Quantitative Chemical Analysis*. 6th Ed., Freeman (2007) Chapters 3-5.
- Levie, R. de, *How to use Excel in analytical chemistry and in general scientific data analysis*, Cambridge Univ. Press (2001) 487 pages.
- Noggle, J. H. *Physical chemistry on a Microcomputer*. Little Brown & Co. (1985).
- Venit, S.M. *Programming in BASIC: Problem solving with structure and style.* Jaico Publishing House: Delhi (1996).

DSE1P: Applications of computers in chemistry (Lab) **Credits 02**

Computer programs based on numerical methods for

1. Roots of equations: (e.g. volume of *van der Waals* gas and comparison with ideal gas, pH of a weak acid).
2. Numerical differentiation (e.g., change in pressure for small change in volume of a van der Waals gas, potentiometric titrations).
3. Numerical integration (e.g. entropy/ enthalpy change from heat capacity data), probability distributions (gas kinetic theory) and mean values.
4. Matrix operations. Application of Gauss-Siedel method in colourimetry.
5. Simple exercises using molecular visualization software.

Suggested Readings:

- McQuarrie, D. A. *Mathematics for Physical Chemistry* University Science Books (2008).
- Mortimer, R. *Mathematics for Physical Chemistry*. 3rd Ed. Elsevier (2005).
- Steiner, E. *The Chemical Maths Book* Oxford University Press (1996).
- Yates, P. *Chemical Calculations.* 2nd Ed. CRC Press (2007).
- Harris, D. C. *Quantitative Chemical Analysis*. 6th Ed., Freeman (2007) Chapters 3-5.
- Levie, R. de, *How to use Excel in analytical chemistry and in general scientific data analysis*, Cambridge Univ. Press (2001) 487 pages.
- Noggle, J. H. *Physical Chemistry on a Microcomputer.* Little Brown & Co. (1985).
- Venit, S.M. *Programming in BASIC: Problem solving with structure and style.* Jaico Publishing House: Delhi (1996).

Or

DSE-2: Green Chemistry **Credits 06**

DSE2T: Green Chemistry **Credits 04**

Course Contents:

Introduction to Green Chemistry

What is Green Chemistry? Need for Green Chemistry. Goals of Green Chemistry. Limitations/ Obstacles in the pursuit of the goals of Green Chemistry

Principles of Green Chemistry and Designing a Chemical synthesis

Twelve principles of Green Chemistry with their explanations and examples and special emphasis on the following:

- Designing a Green Synthesis using these principles; Prevention of Waste/ byproducts; maximum incorporation of the materials used in the process into the final products , Atom Economy, calculation of atom economy of the rearrangement, addition, substitution and elimination reactions.
- Prevention/ minimization of hazardous/ toxic products reducing toxicity. Risk = (function) hazard × exposure; waste or pollution prevention hierarchy.

- Green solvents – supercritical fluids, water as a solvent for organic reactions, ionic liquids, fluorous biphasic solvent, PEG, solvent less processes, immobilized solvents and how to compare greenness of solvents.
- Energy requirements for reactions – alternative sources of energy: use of microwaves and ultrasonic energy.
- Selection of starting materials; avoidance of unnecessary derivatization – careful use of blocking/protecting groups.
- Use of catalytic reagents (wherever possible) in preference to stoichiometric reagents; catalysis and green chemistry, comparison of heterogeneous and homogeneous catalysis, biocatalysis, asymmetric catalysis and photocatalysis.
- Prevention of chemical accidents designing greener processes, inherent safer design, principle of ISD "What you don't have cannot harm you", greener alternative to Bhopal Gas Tragedy (safer route to carcarbaryl) and Flixiborough accident (safer route to cyclohexanol) subdivision of ISD, minimization, simplification, substitution, moderation and limitation.
- Strengthening/ development of analytical techniques to prevent and minimize the generation of hazardous substances in chemical processes.

Green Synthesis/ Reactions and some real world cases:

1. Green Synthesis of the following compounds: adipic acid, catechol, disodium iminodiacetate (alternative to Strecker synthesis)
2. Microwave assisted reactions in water: Hofmann Elimination, methyl benzoate to benzoic acid, oxidation of toluene and alcohols; microwave assisted reactions in organic solvents Diels-Alder reaction and Decarboxylation reaction
3. Ultrasound assisted reactions: sonochemical Simmons-Smith Reaction (Ultrasonic alternative to iodine)
4 Surfactants for carbon dioxide – replacing smog producing and ozone depleting solvents with CO_2 for precision cleaning and dry cleaning of garments.
5 Designing of Environmentally safe marine antifoulant.
6 Rightfit pigment: synthetic azopigments to replace toxic organic and inorganic pigments.
7 n efficient, green synthesis of a compostable and widely applicable plastic (poly lactic acid) made from corn.
8 Healthier fats and oil by Green Chemistry: Enzymatic interesterification for production of no Trans-Fats and Oils
9 Development of Fully Recyclable Carpet: Cradle to Cradle Carpeting

Future Trends in Green Chemistry

Oxidation reagents and catalysts; Biomimetic, multifunctional reagents; Combinatorial green chemistry; Proliferation of solventless reactions; co crystal controlled solid state synthesis (C_2S_3); Green chemistry in sustainable development.

Suggested Readings:

- Ahluwalia, V.K. & Kidwai, M.R. *New Trends in Green Chemistry*, Anamalaya Publishers (2005).
- Anastas, P.T. & Warner, J.K.: *Green Chemistry - Theory and Practical*, Oxford University Press (1998).
- Matlack, A.S. *Introduction to Green Chemistry*, Marcel Dekker (2001).
- Cann, M.C. & Connely, M.E. *Real-World cases in Green Chemistry*, American Chemical Society, Washington (2000).

- Ryan, M.A. & Tinnesand, M. *Introduction to Green Chemistry*, American Chemical Society, Washington (2002).
- Lancaster, M. *Green Chemistry: An Introductory Text* RSC Publishing, 2nd Edition, 2010.

DSE2P: Green Chemistry (Lab) **Credits 02**

Practical:

1. Safer starting materials

Preparation and characterization of nanoparticles of gold using tea leaves.

2. Using renewable resources

Preparation of biodiesel from vegetable/ waste cooking oil.

3. Avoiding waste

- Principle of atom economy.

- Use of molecular model kit to stimulate the reaction to investigate how the atom economy can illustrate Green Chemistry.
- Preparation of propene by two methods can be studied
  (I) Triethylamine ion + OH^- → propene + trimethylpropene + water
  (II) 1-propanol $\xrightarrow{H_2SO_4/\Delta}$ propane + water

- Other types of reactions, like addition, elimination, substitution and rearrangement should also be studied for the calculation of atom economy.

4. Use of enzymes as catalysts

Benzoin condensation using Thiamine Hydrochloride as a catalyst instead of cyanide.

5. Alternative Green solvents

Extraction of D-limonene from orange peel using liquid CO_2 prepared form dry ice.

Mechanochemical solvent free synthesis of azomethines

6. Alternative sources of energy

- Solvent free, microwave assisted one pot synthesis of phthalocyanine complex of copper (II).
- Photoreduction of benzophenone to benzopinacol in the presence of sunlight.

Suggested Readings:

- Anastas, P.T & Warner, J.C. *Green Chemistry: Theory and Practice*, Oxford University Press (1998).
- Kirchoff, M. & Ryan, M.A. *Greener approaches to undergraduate chemistry experiment*. American Chemical Society, Washington DC (2002).
- Ryan, M.A. *Introduction to Green Chemistry*, Tinnesand; (Ed), American Chemical Society, Washington DC (2002).
- Sharma, R.K.; Sidhwani, I.T. & Chaudhari, M.K. I.K. *Green Chemistry Experiment: A monograph International Publishing House Pvt Ltd. New Delhi*. Bangalore CISBN 978-93-81141-55-7 (2013).

- Cann, M.C. & Connelly, M. E. *Real world cases in Green Chemistry*, American Chemical Society (2008).
- Cann, M. C. & Thomas, P. *Real world cases in Green Chemistry*, American Chemical Society (2008).
- Lancaster, M. *Green Chemistry: An Introductory Text* RSC Publishing, 2nd Edition, 2010.
- Pavia, D.L., Lampman, G.M., Kriz, G.S. & Engel, R.G. *Introduction to Organic Laboratory Techniques: A Microscale and Macro Scale Approach,* W.B.Saunders, 1995.

Or

DSE-2: Industrial Chemicals and Environment — Credits 06

DSE2T: Industrial Chemicals and Environment — Credits 04

Course Contents:

Industrial Gases and Inorganic Chemicals

Industrial Gases: Large scale production, uses, storage and hazards in handling of the following gases: oxygen, nitrogen, argon, neon, helium, hydrogen, acetylene, carbon monoxide, chlorine, fluorine, sulphur dioxide and phosgene.

Inorganic Chemicals: Manufacture, application, analysis and hazards in handling the following chemicals: hydrochloric acid, nitric acid, sulphuric acid, caustic soda, common salt, borax, bleaching powder, sodium thiosulphate, hydrogen peroxide, potash alum, chrome alum, potassium dichromate and potassium permanganate.

Industrial Metallurgy

General Principles of Metallurgy

Chief modes of occurrence of metals based on standard electrode potentials. Ellingham diagrams for reduction of metal oxides using carbon as reducing agent. Hydrometallurgy, Methods of purification of metals (Al, Pb, Ti, Fe, Cu, Ni, Zn): electrolytic, oxidative refining, Kroll process, Parting process, van Arkel-de Boer process and Mond's process. Preparation of metals (ferrous and nonferrous) and ultrapure metals for semiconductor technology.

Environment and its segments

Ecosystems. Biogeochemical cycles of carbon, nitrogen and sulphur.

Air Pollution: Major regions of atmosphere. Chemical and photochemical reactions in atmosphere. Air pollutants: types, sources, particle size and chemical nature; Photochemical smog: its constituents and photochemistry. Environmental effects of ozone, Major sources of air pollution. Pollution by SO_2, CO_2, CO, NO_x, H_2S and other foul smelling gases. Methods of estimation of CO, NO_x, SO_x and control procedures. Effects of air pollution on living organisms and vegetation. Greenhouse effect and Global warming, Ozone depletion by oxides of nitrogen, chlorofluorocarbons and Halogens, removal of sulphur from coal. Control of particulates.

Water Pollution: Hydrological cycle, water resources, aquatic ecosystems, Sources and nature of water pollutants, Techniques for measuring water pollution, Impacts of water pollution on hydrological and ecosystems. Water purification methods. Effluent treatment plants (primary, secondary and tertiary treatment). Industrial effluents from the following industries and their treatment: lectroplating, textile, tannery, dairy, petroleum and petrochemicals, agro, fertilizer, etc. Sludge disposal. Industrial waste management, incineration of waste. Water treatment and purification (reverse osmosis, electro dialysis, ion exchange). Water quality parameters for waste water, industrial water and domestic water.

Energy & Environment

Sources of energy: Coal, petrol and natural gas. Nuclear Fusion / Fission, Solar energy, Hydrogen, geothermal, Tidal and Hydel, etc.
Nuclear Pollution: Disposal of nuclear waste, nuclear disaster and its management.

Biocatalysis

Introduction to biocatalysis: Importance in "Green Chemistry" and Chemical Industry.

Suggested Readings:

- E. Stocchi: *Industrial Chemistry*, Vol-I, Ellis Horwood Ltd. UK.
- R.M. Felder, R.W. Rousseau: *Elementary Principles of Chemical Processes*, Wiley Publishers, New Delhi.
- J. A. Kent: *Riegel's Handbook of Industrial Chemistry, CBS Publishers, New Delhi.*
- *S. S. Dara: A Textbook of Engineering Chemistry*, S. Chand & Company Ltd. New Delhi.
- K. De, *Environmental Chemistry*: New Age International Pvt., Ltd, New Delhi.
- S. M. Khopkar, *Environmental Pollution Analysis*: Wiley Eastern Ltd, New Delhi.
- S.E. Manahan, *Environmental Chemistry*, CRC Press (2005).
- G.T. Miller, *Environmental Science* 11th edition. Brooks/ Cole (2006).
- Mishra, *Environmental Studies*. Selective and Scientific Books, New Delhi (2005).

DSE2P: Industrial Chemicals & Environment **Credits 02**

Practical:

1. Determination of dissolved oxygen in water.
2. Determination of Chemical Oxygen Demand (COD)
3. Determination of Biological Oxygen Demand (BOD)
4. Percentage of available chlorine in bleaching powder.
5. Measurement of chloride, sulphate and salinity of water samples by simple titration method ($AgNO_3$ and potassium chromate).
6. Estimation of total alkalinity of water samples (CO_3^{2-} HCO_3^-) using double titration method.
7. Measurement of dissolved CO_2.
8. Study of some of the common bio-indicators of pollution.
9. Estimation of SPM in air samples.
10. Preparation of borax/ boric acid.

Suggested Readings:

- E. Stocchi: *Industrial Chemistry*, Vol-I, Ellis Horwood Ltd. UK.
- R.M. Felder, R.W. Rousseau: *Elementary Principles of Chemical Processes*, Wiley Publishers, New Delhi.
- J. A. Kent: Riegel's *Handbook of Industrial Chemistry*, CBS Publishers, New Delhi.
- S. S. Dara: *A Textbook of Engineering Chemistry*, S. Chand & Company Ltd. New Delhi.
- K. De, *Environmental Chemistry*: New Age International Pvt. Ltd, New Delhi.
- S. M. Khopkar, *Environmental Pollution Analysis*: Wiley Eastern Ltd, New Delhi.

Or

DSE-2: Quantum Chemistry, Spectroscopy & Photochemistry Credits 06

DSE2T: Quantum Chemistry, Spectroscopy & Photochemistry Credits 04

Course Contents:

Quantum Chemistry

Postulates of quantum mechanics, quantum mechanical operators, Schrödinger equation and its application to free particle and "particle-in-a-box" (rigorous treatment), quantization of energy levels, zero-point energy and Heisenberg Uncertainty principle; wavefunctions, probability distribution functions, nodal properties, Extension to two and three dimensional boxes, separation of variables, degeneracy.

Qualitative treatment of simple harmonic oscillator model of vibrational motion: Setting up of Schrödinger equation and discussion of solution and wave functions. Vibrational energy of diatomic molecules and zero-point energy.

Angular momentum: Commutation rules, quantization of square of total angular momentum and z-component. Rigid rotator model of rotation of diatomic molecule. Schrödinger equation, transformation to spherical polar coordinates. Separation of variables. Spherical harmonics. Discussion of solution.

Qualitative treatment of hydrogen atom and hydrogen like ions: setting up of Schrödinger equation in spherical polar coordinates, radial part, quantization of energy (only final energy expression). Average and most probable distances of electron from nucleus. Setting up of Schrödinger equation for many-electron atoms (He, Li). Need for approximation methods. Statement of variation theorem and application to simple systems (particle-in-a-box, harmonic oscillator, hydrogen atom).

Chemical bonding: Covalent bonding, valence bond and molecular orbital approaches, LCAO-MO treatment of H_2^+. Bonding and antibonding orbitals. Qualitative extension to H_2. Comparison of LCAO-MO and VB treatments of H_2 (only wave functions, detailed solution not required) and their limitations. Refinements of the two approaches (Configuration Interaction for MO, ionic terms in VB). Qualitative description of LCAO-MO treatment of homonuclear and heteronuclear diatomic molecules (HF, LiH). Localised and non-localised molecular orbitals treatment of triatomic (BeH_2, H_2O) molecules. Qualitative MO theory and its application to AH_2 type molecules.

Molecular Spectroscopy:

Interaction of electromagnetic radiation with molecules and various types of spectra; Born Oppenheimer approximation.

Rotation spectroscopy: Selection rules, intensities of spectral lines, determination of bond lengths of diatomic and linear triatomic molecules, isotopic substitution.

Vibrational spectroscopy: Classical equation of vibration, computation of force constant, amplitude of diatomic molecular vibrations, anharmonicity, Morse potential, dissociation energies, fundamental frequencies, overtones, hot bands, degrees of freedom for polyatomic molecules, modes of vibration, concept of group frequencies. Vibration-rotation spectroscopy: diatomic vibrating rotator, P, Q, R branches.

Raman spectroscopy: Qualitative treatment of Rotational Raman effect; Effect of nuclear spin, Vibrational Raman spectra, Stokes and anti-Stokes lines; their intensity difference, rule of mutual exclusion.

Electronic spectroscopy: Franck-Condon principle, electronic transitions, singlet and triplet states, fluorescence and phosphorescence, dissociation and predissociation, calculation of electronic transitions of polyenes using free electron model.

Nuclear Magnetic Resonance (NMR) spectroscopy: Principles of NMR spectroscopy, Larmor precession, chemical shift and low resolution spectra, different scales, spin-spin coupling and high resolution spectra, interpretation of PMR spectra of organic molecules.

Electron Spin Resonance (ESR) spectroscopy: Its principle, hyperfine structure, ESR of simple radicals.

Photochemistry

Characteristics of electromagnetic radiation, Lambert-Beer's law and its limitations, physical significance of absorption coefficients. Laws, of photochemistry, quantum yield, actinometry, examples of low and high quantum yields, photochemical equilibrium and the differential rate of photochemical reactions, photosensitised reactions, quenching. Role of photochemical reactions in biochemical processes, photostationary states, chemiluminescence.

Suggested Readings:

- Banwell, C. N. & McCash, E. M. *Fundamentals of Molecular Spectroscopy* 4th Ed. Tata McGraw-Hill: New Delhi (2006).
- Chandra, A. K. *Introductory Quantum Chemistry* Tata McGraw-Hill (2001).
- House, J. E. *Fundamentals of Quantum Chemistry* 2nd
- Ed. Elsevier: USA (2004).
- Lowe, J. P. & Peterson, K. *Quantum Chemistry*, Academic Press (2005).
- Kakkar, R. *Atomic & Molecular Spectroscopy*: *Concepts & Applications*, Cambridge University Press (2015).

DSE2P: Practical **Credits 02**

UV/Visible spectroscopy

I. Study the 200-500 nm absorbance spectra of $KMnO_4$ and $K_2Cr_2O_7$ (in 0.1 M H_2SO_4) and determine the λ_{max} values. Calculate the energies of the two transitions in different units (J molecule^{-1}, kJ mol^{-1} , cm^{-1} , eV).
II. Study the pH-dependence of the UV-Vis spectrum (200-500 nm) of $K_2Cr_2O_7$.
III. Record the 200-350 nm UV spectra of the given compounds (acetone, acetaldehyde, 2-propanol, acetic acid) in water. Comment on the effect of structure on the UV spectra of organic compounds.

Colourimetry

I. Verify Lambert-Beer's law and determine the concentration of $CuSO_4$/$KMnO_4$/$K_2Cr_2O_7$ in a solution of unknown concentration
II. Determine the concentrations of $KMnO_4$ and $K_2Cr_2O_7$ in a mixture.
III. Study the kinetics of iodination of propanone in acidic medium.
IV. Determine the amount of iron present in a sample using 1,10-phenathroline.
V. Determine the dissociation constant of an indicator (phenolphthalein).
VI. Study the kinetics of interaction of crystal violet/ phenolphthalein with sodium hydroxide.
VII. Analyse the given vibration-rotation spectrum of HCl (g)

Suggested Readings:

- Mendham, J. *Vogel's Quantitative Chemical Analysis*, Pearson, 2009.
- Khosla, B. D.; Garg, V. C. & Gulati, A., *Senior Practical Physical Chemistry*, R. Chand & Co.: New Delhi (2011).
- Garland, C. W.; Nibler, J. W. & Shoemaker, D. P. *Experiments in Physical Chemistry 8th Ed.;* McGraw-Hill: New York (2003).
- Halpern, A. M. & McBane, G. C. *Experimental Physical Chemistry 3rd Ed.;* W.H. Freeman & Co.: New York (2003).

Or

DSE-2: Molecular Modelling & Drug design — Credits 06

DSE2T: Molecular Modelling & Drug design — Credits 04

Course Contents:

Introduction to Molecular Modelling:

Introduction. Useful Concepts in Molecular Modelling: Coordinate Systems. Potential Energy Surfaces. Molecular Graphics. Surfaces. Computer Hardware and Software. The Molecular Modelling Literature.

Force Fields:

Fields. Bond Stretching. Angle Bending. Introduction to non-bonded interactions. Electrostatic interactions. *van der Waals* Interactions. Hydrogen bonding in Molecular Mechanics. Force Field Models for the Simulation of Liquid Water.

Energy Minimization and Computer Simulation:

Minimization and related methods for exploring the energy surface. Non-derivative method, First and second order minimization methods. Computer simulation methods. Simple thermodynamic properties and Phase Space. Boundaries. Analyzing the results of a simulation and estimating Errors.

Molecular Dynamics & Monte Carlo Simulation:

Molecular Dynamics Simulation Methods. Molecular Dynamics using simple models. Molecular Dynamics with continuous potentials. Molecular Dynamics at constant temperature and pressure. Metropolis method. Monte Carlo simulation of molecules. Models used in Monte Carlo simulations of polymers.

Structure Prediction and Drug Design:

Structure prediction - Introduction to comparative Modelling. Sequence alignment. Constructing and evaluating a comparative model. Predicting protein structures by 'Threading', Molecular docking. Structure based de novo ligand design, Drug Discovery – Chemo informatics – QSAR.

Suggested Readings:

- Leach, A.R. *Molecular Modelling Principles and Application*, Longman, 2001.
- Haile, J.M. *Molecular Dynamics Simulation Elementary Methods*, John Wiley and Sons, 1997.
- Gupta, S.P. *QSAR and Molecular Modeling*, Springer - Anamaya Publishers, 2008.

DSE2P: Molecular Modelling & Drug design (Lab) Credits 02

Practical:

i. Compare the optimized C-C bond lengths in ethane, ethene, ethyne and benzene. Visualize the molecular orbitals of the ethane σ bonds and ethene, ethyne, benzene and pyridine π bonds.

ii. (a) Perform a conformational analysis of butane.
(b) Determine the enthalpy of isomerization of *cis* and *trans* 2-butene.

iii. Visualize the electron density and electrostatic potential maps for LiH, HF, N_2, NO and CO and comment. Relate to the dipole moments. Animate the vibrations of these molecules.

iv. (a) Relate the charge on the hydrogen atom in hydrogen halides with their acid character.
(b) Compare the basicities of the nitrogen atoms in ammonia, methylamine, dimethylamine and trimethylamine.

v. (a) Compare the shapes of the molecules: 1-butanol, 2-butanol, 2-methyl-1-propanol, and 2-methyl-2-propanol. Note the dipole moment of each molecule.
(b) Show how the shapes affect the trend in boiling points: (118 ºC, 100 ºC, 108 ºC, 82 ºC, respectively).

vi. Build and minimize organic compounds of your choice containing the following functional groups. Note the dipole moment of each compound:
(a) alkyl halide (b) aldehyde (c) ketone (d) amine (e) ether (f) nitrile (g) thiol (h) carboxylic acid (i) ester (j) amide.

vii. (a) Determine the heat of hydration of ethylene.
(b) Compute the resonance energy of benzene by comparison of its enthalpy of hydrogenation with that of cyclohexene.

viii. Arrange 1-hexene, 2-methyl-2-pentene, (*E*)-3-methyl-2-pentene, (*Z*)-3-methyl-2-pentene, and 2,3-dimethyl-2-butene in order of increasing stability.

ix. (a) Compare the optimized bond angles H_2O, H_2S, H_2Se.
(b) Compare the HAH bond angles for the second row dihydrides and compare with the results from qualitative MO theory.

Note: Software: ChemSketch, ArgusLab (www.planaria-software.com), TINKER 6.2 (dasher.wustl.edu/ffe), WebLab Viewer, Hyperchem, or any similar software.

Suggested Readings:

- Leach, A.R. *Molecular Modelling Principles and Application*, Longman, 2001.
- Haile, J.M. *Molecular Dynamics Simulation Elementary Methods*, John Wiley and Sons, 1997.
- Gupta, S.P. *QSAR and Molecular Modeling*, Springer - Anamaya Publishers, 2008.

Skill Enhancement Course (SEC)

SEC-1: Basic Analytical Chemistry — Credits 02

SEC1T: Basic Analytical Chemistry — Credits 01

Course Contents:

Introduction: Introduction to Analytical Chemistry and its interdisciplinary nature. Concept of sampling. Importance of accuracy, precision and sources of error in analytical measurements. Presentation of experimental data and results, from the point of view of significant figures.

Analysis of soil: Composition of soil, Concept of pH and pH measurement, Complexometric titrations, Chelation, Chelating agents, use of indicators.

Analysis of water: Definition of pure water, sources responsible for contaminating water, water sampling methods, water purification methods.

Analysis of food products: Nutritional value of foods, idea about food processing and food preservations and adulteration.

Chromatography: Definition, general introduction on principles of chromatography, paper chromatography, TLC etc.

Ion-exchange: Column, ion-exchange chromatography etc. Determination of ion exchange capacity of anion / cation exchange resin (using batch procedure if use of column is not feasible).

Analysis of cosmetics: Major and minor constituents and their function.

SEC1P: Practical — Credits 01

A:

1. Determination of pH of soil samples.

2. Estimation of Calcium and Magnesium ions as Calcium carbonate by complexometric titration.
3. Determination of pH, acidity and alkalinity of a water sample.
4. Determination of dissolved oxygen (DO) of a water sample.
5. Identification of adulterants in some common food items like coffee powder, asafoetida,chilli powder, turmeric powder, coriander powder and pulses, etc.
6. Analysis of preservatives and colouring matter.
7. Paper chromatographic separation of mixture of metal ion (Fe^{3+} and Al^{3+}).
8. To compare paint samples by TLC method.
9. Determination of ion exchange capacity of anion / cation exchange resin (using batch procedure if use of column is not feasible).
10. Analysis of deodorants and antiperspirants, Al, Zn, boric acid, chloride, sulphate.
11. Determination of constituents of talcum powder: Magnesium oxide, Calcium oxide, Zinc oxide and Calcium carbonate by complexometric titration.

B:

Suggested Applications (Any one):

1. To study the use of phenolphthalein in trap cases.
2. To analyze arson accelerants.
3. To carry out analysis of gasoline.

C:

Suggested Instrumental demonstrations:

1. Estimation of macro nutrients: Potassium, Calcium, Magnesium in soil samples by flame photometry.
2. Spectrophotometric determination of Iron in Vitamin / Dietary Tablets.
3. Spectrophotometric Identification and Determination of Caffeine and Benzoic Acid in Soft Drink.

Suggested Readings:

- Willard, H.H., Merritt, L.L., Dean, J. & Settoe, F.A. *Instrumental Methods of Analysis*. 7th Ed. Wadsworth Publishing Co. Ltd., Belmont, California, USA.
- Skoog, D.A. Holler F.J. & Nieman, T.A. *Principles of Instrumental Analysis*, Cengage Learning India Ed.
- Skoog, D.A.; West, D.M. & Holler, F.J. *Fundamentals of Analytical Chemistry 6th Ed.*, Saunders College Publishing, Fort Worth.
- Harris, D. C. *Quantitative Chemical Analysis*, W. H. Freeman.
- Dean, J. A. *Analytical Chemistry Notebook*, McGraw Hill.
- Day, R. A. & Underwood, A. L. *Quantitative Analysis*, Prentice Hall of India.
- Freifelder, D. *Physical Biochemistry 2nd Ed.*, W.H. Freeman and Co., N.Y. USA.
- Cooper, T.G. *The Tools of Biochemistry*, John Wiley and Sons, N.Y. USA.
- Vogel, A. I. *Vogel's Qualitative Inorganic Analysis 7th Ed.*, Prentice Hall.
- Vogel, A. I. Vogel's *Quantitative Chemical Analysis 6th Ed.*, Prentice Hall.
- Robinson, J.W. *Undergraduate Instrumental Analysis 5th Ed.*, Marcel Dekker, Inc., New York.

Or

SEC-1: Chemo informatics Credits 02

SEC1T: Chemo informatics

Course Contents:

Introduction to Chemo informatics:

History and evolution of chemo informatics, Use of chemo informatics, Prospects of chemo informatics, Molecular Modelling and Structure elucidation.

Representation of molecules and chemical reactions:

Nomenclature, Different types of notations, SMILES coding, Matrix representations, Structure of Molfiles and Sdfiles, Libraries and toolkits, Different electronic effects, Reaction classification.

Searching chemical structures:
Full structure search, sub-structure search, basic ideas, similarity search, three dimensional search methods, basics of computation of physical and chemical data and structure descriptors, data visualization.

Applications:

Prediction of Properties of Compounds; Linear Free Energy Relations; Quantitative Structure-Property Relations; Descriptor Analysis; Model Building; Modeling Toxicity; Structure-Spectra correlations; Prediction of NMR, IR and Mass spectra; Computer Assisted Structure elucidations; Computer Assisted Synthesis Design, Introduction to drug design; Target Identification and Validation; Lead Finding and Optimization; Analysis of HTS data; Virtual Screening; Design of Combinatorial Libraries; Ligand-Based and Structure Based Drug design; Application of Chemoinformatics in Drug Design.

Suggested Readings:

- Andrew R. Leach & Valerie, J. Gillet (2007) *An introduction to Chemoinformatics.* Springer: The Netherlands.
- Gasteiger, J. & Engel, T. (2003) *Chemoinformatics: A text-book.* Wiley-VCH.
- Gupta, S. P. (2011) *QSAR & Molecular Modeling.* Anamaya Pub.: New Delhi.

SEC-2: Intellectual Property Rights (IPR) Credits 02

SEC2T: Intellectual Property Rights (IPR)

Course Contents:

Introduction to Intellectual Property: Historical Perspective, Different Types of IP, Importance of protecting IP.

Copyrights: Introduction, How to obtain, Differences from Patents.

Trade Marks: Introduction, How to obtain, Different types of marks – Collective marks, certification marks, service marks, Trade names, etc. Differences from Designs.

Patents: Historical Perspective, Basic and associated right, WIPO, PCT system, Traditional Knowledge, Patents and Healthcare – balancing promoting innovation with public health, Software patents and their importance for India.

Geographical indications: Definition, rules for registration, prevention of illegal exploitation, importance to India.

Industrial Designs: Definition, How to obtain, features, International design registration.

Layout design of integrated circuits: Circuit Boards, Integrated Chips, Importance for electronic industry.

Trade Secrets: Introduction and Historical Perspectives, Scope of Protection, Risks involved and legal aspects of Trade Secret Protection.

Different International agreements

(a) Word Trade Organization (WTO):

(i) General Agreement on Tariffs & Trade (GATT), Trade Related Intellectual Property Rights (TRIPS) agreement
(ii) General Agreement on Trade related Services (GATS)
(iii) Madrid Protocol
(iv) Berne Convention
(v) Budapest Treaty

(b) Paris Convention

WIPO and **TRIPS, IPR** and Plant Breeders Rights, IPR and Biodiversity

IP Infringement issue and enforcement – Role of Judiciary, Role of law enforcement agencies – Police, Customs etc. Economic Value of Intellectual Property – Intangible assets and their valuation, Intellectual Property in the Indian Context – Various laws in India Licensing and technology transfer.

Suggested Readings:

- N.K. Acharya: *Textbook on intellectual property rights*, Asia Law House .
- Manjula Guru & M.B. Rao, *Understanding Trips: Managing Knowledge in Developing Countries*, Sage Publications.
- P. Ganguli, Intellectual Property Rights: *Unleashing the Knowledge Economy*, Tata McGraw-Hill.
- Arthur Raphael Miller, Micheal H.Davis; *Intellectual Property: Patents, Trademarks and Copyright in a Nutshell*, West Group Publishers (2000).
- Jayashree Watal, *Intellectual property rights in the WTO and developing countries*, Oxford University Press, Oxford.

Or

SEC-2: Analytical Clinical Biochemistry Credits 02

SEC2T: Analytical Clinical Biochemistry Credits 01

Course Contents:

Basic understanding of the structures, properties and functions of carbohydrates, lipids and proteins:

Review of concepts studied in the core course:

Carbohydrates: Biological importance of carbohydrates, Metabolism, Cellular currency of energy (ATP), Glycolysis, Alcoholic and Lactic acid fermentations, Krebs cycle. Isolation and characterization of polysachharides.

Proteins: Classification, biological importance; Primary and secondary and tertiary structures of proteins: α-helix and β- pleated sheets, Isolation, characterization, denaturation of proteins.

Enzymes: Nomenclature, Characteristics (mention of Ribozymes), Classification; Active site, Mechanism of enzyme action, Stereospecificity of enzymes, Coenzymes and cofactors, Enzyme inhibitors, Introduction to Biocatalysis: Importance in "Green Chemistry" and Chemical Industry.

Lipids: Classification. Biological importance of triglycerides and phosphoglycerides and cholesterol; Lipid membrane, Liposomes and their biological functions and underlying applications. Lipoproteins.

Hormone : Properties, functions and biochemical functions of steroid hormones. Biochemistry of peptide hormones.

Structure of DNA (Watson-Crick model) and RNA, Genetic Code, Biological roles of DNA and RNA: Replication, Transcription and Translation, Introduction to Gene therapy.

Enzymes: Nomenclature, classification, effect of pH, temperature on enzyme activity, enzyme inhibition.

Biochemistry of disease: A diagnostic approach by blood/ urine analysis.

Blood: Composition and functions of blood, blood coagulation. Blood collection and preservation of samples. Anaemia, Regulation, estimation and interpretation of data for blood sugar, urea, creatinine, cholesterol and bilirubin.
Urine: Collection and preservation of samples. Formation of urine. Composition an estimation of constituents of normal and pathological urine.

SEC2P: Practical Credit 01

Practical
Identification and estimation of the following:

1. Carbohydrates – qualitative and quantitative.

2. Lipids – qualitative.
3. Determination of the iodine number of oil.
4. Determination of the saponification number of oil.
5. Determination of cholesterol using Liebermann- Burchard reaction.
6. Proteins – qualitative.
7. Isolation of protein.
8. Determination of protein by the Biuret reaction.
9. Determination of nucleic acids

Suggested Readings:

- T.G. Cooper: Tool of Biochemistry.
- Keith Wilson and John Walker: Practical Biochemistry.
- Alan H Gowenlock: Varley's Practical Clinical Biochemistry.
- Thomas M. Devlin: Textbook of Biochemistry.
- Berg, J.M., Tymoczko, J.L. & Stryer, L. *Biochemistry*, W.H. Freeman, 2002.
- Talwar, G.P. & Srivastava, M. *Textbook of Biochemistry and Human Biology*, 3rd Ed. PHI Learning.
- Nelson, D. L. & Cox, M. M. *Lehninger's Principles of Biochemistry 7th Ed.*, W. H. Freeman.
- Mikes, O. *Laboratory Hand Book of Chromatographic & Allied Methods*, Elles Harwood Series on Analytical Chemistry, John Wiley & Sons, 1979.

SEC-3: Pharmaceutical Chemistry — Credits 02

SEC3T: Pharmaceutical Chemistry — Credits 01

Course Contents:

Drugs & Pharmaceuticals:

Drug discovery, design and development; Basic Retrosynthetic approach. Synthesis of the representative drugs of the following classes: analgesics agents, antipyretic agents, antiinflammatory agents (Aspirin, paracetamol, lbuprofen); antibiotics (Chloramphenicol); antibacterial and antifungal agents (Sulphonamides; Sulphanethoxazol, Sulphacetamide, Trimethoprim); antiviral agents (Acyclovir), Central Nervous System agents (Phenobarbital, Diazepam),Cardiovascular (Glyceryl trinitrate), antilaprosy (Dapsone), HIV-AIDS related drugs (AZT- Zidovudine).

Fermentation:

Aerobic and anaerobic fermentation. Production of (i) Ethyl alcohol and citric acid, (ii) Antibiotics; Penicillin, Cephalosporin, Chloromycetin and Streptomycin, (iii) Lysine, Glutamic acid, Vitamin B2, Vitamin B12 and Vitamin C.

SEC3P: Practical — Credit 01

Practical:

1. Preparation of Aspirin and its analysis.
2. Preparation of magnesium bisilicate (Antacid).

Suggested Readings:

- G.L. Patrick: Introduction to *Medicinal Chemistry, Oxford University* Press, UK.
- Hakishan, V.K. Kapoor: *Medicinal and Pharmaceutical Chemistry,* Vallabh Prakashan, Pitampura, New Delhi.
- William O. Foye, Thomas L., Lemke , David A. William: *Principles of Medicinal Chemistry*, B.I. Waverly Pvt. Ltd. New Delhi.

Or

SEC-3: Chemistry of Cosmetics & Perfumes — Credits 02

SEC3T: Chemistry of Cosmetics & Perfumes — Credits 01

Course Contents:

A general study including preparation and uses of the following: Hair dye, hair spray, shampoo, suntan lotions, face powder, lipsticks, talcum powder, nail enamel, creams (cold, vanishing and shaving creams), antiperspirants and artificial flavours. Essential oils and their importance in cosmetic industries with reference to Eugenol, Geraniol, sandalwood oil, eucalyptus, rose oil, 2-phenyl ethyl alcohol, Jasmone, Civetone, Muscone.

SEC3P: Practical — Credit 01

1. Preparation of talcum powder.
2. Preparation of shampoo.
3. Preparation of enamels.
4. Preparation of hair remover.
5. Preparation of face cream.
6. Preparation of nail polish and nail polish remover.

Suggested Readings:

- E. Stocchi: *Industrial Chemistry*, Vol -I, Ellis Horwood Ltd. UK.
- P.C. Jain, M. Jain: *Engineering Chemistry*, Dhanpat Rai & Sons, Delhi.
- Sharma, B.K. & Gaur, H. *Industrial Chemistry,* Goel Publishing House, Meerut (1996).

SEC-4: Pesticide Chemistry — Credits 02

SEC4T: Pesticide Chemistry — Credits 01

Course Contents:

General introduction to pesticides (natural and synthetic), benefits and adverse effects, changing concepts of pesticides, structure activity relationship, synthesis and technical manufacture and uses of representative pesticides in the following classes: Organochlorines (DDT, Gammexene,);

Organophosphates (Malathion, Parathion); Carbamates (Carbofuran and carbaryl); Quinones (Chloranil), Anilides (Alachlor and Butachlor).

SEC4P: Practical **Credit 01**

1 To calculate acidity/alkalinity in given sample of pesticide formulations as per BIS specifications.
2 Preparation of simple organophosphates, phosphonates and thiophosphates

Suggested Readings:

- Cremlyn, R. *Pesticides. Preparation and Modes of Action*, John Wiley & Sons, New York, 1978.

Or

SEC- 4: Fuel Chemistry Credits 02

SEC4T: Fuel Chemistry

Course Contents:

Introduction: Review of energy sources (renewable and non-renewable). Classification of fuels and their calorific value.

Coal: Uses of coal (fuel and nonfuel) in various industries, its composition, carbonization of coal. Coal gas, producer gas and water gas—composition and uses. Fractionation of coal tar, uses of coal tar bases chemicals, requisites of a good metallurgical coke, Coal gasification (Hydro gasification and Catalytic gasification), Coal liquefaction and Solvent Refining. **Petroleum and Petrochemical Industry:** Composition of crude petroleum, Refining and different types of petroleum products and their applications. Fractional Distillation (Principle and process), Cracking (Thermal and catalytic cracking), Reforming Petroleum and non-petroleum fuels (LPG, CNG, LNG, bio-gas, fuels derived from biomass), fuel from waste, synthetic fuels (gaseous and liquids), clean fuels. **Petrochemicals:** Vinyl acetate, Propylene oxide, Isoprene, Butadiene, Toluene and its derivatives Xylene. **Lubricants:** Classification of lubricants, lubricating oils (conducting and non-conducting), Solid and semisolid lubricants, synthetic lubricants. Properties of lubricants (viscosity index, cloud point, pore point) and their determination.

Suggested Readings:

- Stocchi, E. *Industrial Chemistry*, Vol-I, Ellis Horwood Ltd. UK (1990).
- Jain, P.C. & Jain, M. *Engineering Chemistry* Dhanpat Rai & Sons, Delhi.
- Sharma, B.K. & Gaur, H. *Industrial Chemistry*, Goel Publishing House, Meerut (1996).

Vidyasagar University

Dept. of Chemistry and Chemical Technology

Syllabus 2018

For

M.Sc. in Chemistry

Under Choice Based Credit System (CBCS)
(Semester Programme)

[w. e. f. 2018-19 session]

M.Sc. in **CHEMISTRY**

SEMESTER	COURSE NO.	COURSE TITLES	Full Marks	Credit
I	CEM 101	PHYSICAL CHEMISTRY - I	50	4
	CEM 102	ORGANIC CHEMISTRY- I	50	4
	CEM 103	INORGANIC CHEMISTRY- I	50	4
	CEM 104	FOOD PROCESSING AND PRESERVATION AND COMPUTER BASICS	50	4
	CEM 195	INORGANIC CHEMISTRY (practical)	50	4
	CEM 196	FOOD PROCESSING AND PRESERVATION (practical)	50	4
		TOTAL	300	24
II	CEM 201	PHYSICAL CHEMISTRY-II	50	4
	CEM 202	ORGANIC CHEMISTRY-II	50	4
	CEM 203	INORGANIC CHEMISTRY-II	50	4
	C-CEM 204	*NANOTECHNOLOGY:PRINCIPLES AND PRACTICES(CBCS)*	50	4
	CEM 295	ORGANIC CHEMISTRY (practical)	50	4
	CEM 296	PHYSICAL CHEMISTRY (practical)	50	4
		TOTAL	300	24
	CEM 301	ADVANCED SPECTROSCOPY-I	50	
		PHYSICAL CHEMISTRY SPECIALISATION		
	CEM 302	ADVANCED PHYSICAL CHEMISTRY-I	50	4
	CEM 303	ADVANCED PHYSICAL CHEMISTRY-II	50	4
		INORGANIC CHEMISTRY SPECIALISATION		
	CEM 302	ADVANCED INORGANIC CHEMISTRY-I	50	4
	CEM 303	ADVANCED INORGANIC CHEMISTRY-II	50	4
		ORGANIC CHEMISTRY SPECIALISATION		
	CEM 302	ADVANCED ORGANIC CHEMISTRY-I	50	4
	CEM 303	ADVANCED ORGANIC CHEMISTRY-II	50	4
	C-CEM 304	*INTRODUCTION TO PHARMACEUTICAL CHEMISTRY(CBCS)*	50	4
	CEM 395	CHEMISTRY PROJECT-I(PHYSICAL SPL/ORGANIC SPL/INORGANIC SPL)	100	8
		TOTAL	300	24
IV	CEM 401	ADVANCED SPECTROSCOPY-II	50	4
		PHYSICAL CHEMISTRY SPECIALISATION		
	CEM 402	ADVANCED PHYSICAL CHEMISTRY-III	50	4
	CEM 403	ADVANCED PHYSICAL CHEMISTRY-IV	50	4
	CEM 404	CHEMISTRY IN TECHNOLOGY	50	4
		INORGANIC CHEMISTRY SPECIALISATION		
	CEM 402	ADVANCED INORGANIC CHEMISTRY-I	50	4
	CEM 403	ADVANCED INORGANIC CHEMISTRY-II	50	4
	CEM 404	CHEMISTRY IN TECHNOLOGY	50	4
		ORGANIC CHEMISTRY SPECIALISATION		
	CEM 402	ADVANCED ORGANIC CHEMISTRY-III	50	4
	CEM 403	ADVANCED ORGANIC CHEMISTRY-IV	50	4
	CEM 404	CHEMICAL PRINCIPLES IN FOOD SCIENCE AND TECHNOLOGY	50	4
	CEM 495	CHEMISTRY PROJECT-II (PHYSICAL SPL/ORGANIC SPL/ INORGANIC SPL)	100	8
		TOTAL	300	24
		ALL TOTAL	1200	96

Overview

Semester	Paper	No of Papers	Full Marks of Each Paper	Credit Point of Each Paper	Total Marks	Credit Points	Total Credit Point
1st	Theoretical	4	40+10 = 50	4	200	16	24
	Practical	2	50	4	100	8	
2nd	Theoretical	4	40+10 = 50	4	200	16	24
	Practical	2	50	4	100	8	
3rd	Theoretical	4	40+10 = 50	4	200	16	24
	Practical (Project)	1	100	8	100	8	
4th	Theoretical	4	40+10 = 50	4	200	16	24
	Practical (Project)	1	100	8	100	8	
Grand Total 96 Credit Points							

1st semester: General Course				
Paper	**Course**	**Duration**	**Marks**	**Credit Point**
CEM 101	**Physical Chemistry-I**	45L	**50**	**4**
Unit I	Mathematical preliminaries & Quantum Mechanics-I			
Unit II	Thermodynamics			
Unit III	Statistical Mechanics I			
Unit IV	Fundamentals of Nanoscience and Technology			
Unit V	Principles of molecular spectroscopy-I			
CEM-102	**Organic Chemistry-I**	45L	**50**	**4**
Unit I	Pericyclic reaction-1			
Unit II	Organic transformations / synthesis / reagents			
Unit III	Natural products- terpenoids			
Unit IV	Natural products- alkaloids			
Unit V	Retro-synthesis I			
CEM-103	**Inorganic Chemistry-I**	45L	**50**	**4**
Unit I	Symmetry and Group theory-I			
Unit II	Solid state chemistry and Crystallography			
Unit III	Bioinorganic chemistry-I			
CEM-104	**Food processing and preservation and Computer basics**	45L	**50**	**4**
Unit I	Constituents of food, food pigments and flavouring agents			
Unit II	Introduction to food microbiology			
Unit III	Food preservation: Principles and methods			
Unit IV	Computer basics I			
Unit V	Computer basics I; data manipulation			
CEM-195	**Inorganic Chemistry Practical**	8 Weeks	**50**	**4**
CEM-196	**Food processing preservation and packaging Practical**	8 Weeks	**50**	**4**
			Total Marks	**300**
			Total Credit	**24**

2nd Semester: General Course				
Paper	**Course**	**Duration**	**Marks**	**Credit Point**
CEM-201 Unit I Unit II Unit III Unit IV Unit V	**Physical Chemistry-II** Quantum Mechanics-II Chemical kinetics-I Electrochemistry Molecular spectroscopy-II Surface chemistry	45L	**50**	**4**
CEM-202 Unit I Unit II Unit III Unit IV Unit V	**Organic Chemistry-II** Pericyclic reaction-2 Organic transformations/synthesis/reagents chemistry-2 Retrosynthetic analysis II Stereochemistry-1 Stereochemistry-2,	45L	**50**	**4**
CEM-203 Unit I Unit II Unit III	**Inorganic Chemistry-II** Organometallic chemistry -I Group theory-II Chemistry of p and d-block elements	45L	**50**	**4**
CEM-204 **(Elective Course)**	**Nanotechnology: Principles and Practices** Introduction, synthesis of nanomaterials, analysis techniques, application of nanotechlogy	45L	**50**	**4**
CEM-295	**Organic Chemistry Practical**	8 Weeks	**50**	**4**
CEM-296	**Physical Chemistry Practical**	8 Weeks	**50**	**4**
			Total Marks	**300**
			Total Credit	**24**

3rd Semester: Physical Chemistry Spl.				
Paper	Course	**Duration**	**Marks**	**Credit Point**
CEM-301	**Advanced Spectroscopy-I**	45L	**50**	**4**
Unit I	Photophysical Processes			
Unit II	LASERs and its applications			
Unit III	EPR spectroscopy			
Unit IV	PES and NQR spectroscopy			
CEM-302	**Advanced Physical Chemistry-I**	45L	**50**	**4**
Unit I	Matrix mechanics			
Unit II	Stationary perturbation theory			
Unit III	Semiclassical radiation – matter interaction			
Unit IV	Semiemperical methods in quantum chemistry			
Unit V	Group theory & quantum mechanics			
CEM-303	**Advanced Physical Chemistry-II**	45L	**50**	**4**
Unit I	Solid state chemistry I			
Unit II	Solid state chemistry II			
Unit III	*Statistical mechanics II*			
Unit IV	Statistical mechanics III			
Unit V	Non equilibrium theromodynamics			
C-CEM 304	**Introduction of Pharmaceutical Chemistry (CBCS)** : Classification and nomenclature of drugs,Theory of drug action and factors affectingthe drugs, Types of drugs, Antimalarial drugs	45L	**50**	**4**
CEM-395	**Physical Chemistry Project I**	16 Weeks	**100**	**8**
	Total Marks		300	
	Total Credit			24

3rd Semester: Inorganic Chemistry Spl.				
Paper	Course	**Duration**	**Marks**	**Credit Point**
CEM-301	**Advanced Spectroscopy-I**	45L	**50**	**4**
Unit I	Photophysical Processes			
Unit II	LASERs and its applications			
Unit III	EPR spectroscopy			
Unit IV	PES and NQR spectroscopy			
CEM-302	**Advanced Inorganic Chemistry-I**	45L	**50**	**4**
Unit I	Organometallic chemistry – II and catalysis			
Unit II	Chemical applications of group theory			
CEM-303	**Advanced Inorganic Chemistry-II**	45L	**50**	**4**
Unit I	Bioinorganic chemistry – II			
Unit II	Inorganic photochemistry			
C-CEM 304	**Introduction of Pharmaceutical Chemistry (CBCS):** Classification and nomenclature of drugs, Theory of drug action and factors affecting the drugs, Types of drugs, Antimalarial drugs	45L	**50**	**4**
CEM-395	**Inorganic Chemistry Project I**	16 Weeks	**100**	**8**
	Total Marks		300	
	Total Credit			24

3rd Semester: Organic Chemistry Spl.				
Paper	Course	**Duration**	**Marks**	**Credit Point**
CEM 301	**Advanced Spectroscopy-I**	45L	**50**	**4**
Unit I	Photophysical Processes			
Unit II	LASERs and its applications			
Unit III	EPR spectroscopy			
Unit IV	PES and NQR spectroscopy			
CEM 302	**Advanced Organic Chemistry-I**	45L	**50**	**4**
Unit I	Pericyclic Reaction-III			
Unit II	Linear free energy relationship I			
Unit III	Linear free energy relationship II			
Unit IV	Organometallic Chemistry			
CEM 303	**Advanced Organic Chemistry II**	45L	**50**	**4**
Unit I	Bioorganic and Supramolecular Chemistry-I			
Unit II	Bioorganic and Supramolecular Chemistry-II			
Unit III	Bioorganic and Supramolecular Chemistry-III			
Unit IV	Peptides and Nucleic acids			
Unit V	Green Chemistry.			
C-CEM 304	**Introduction of Pharmaceutical Chemistry (CBCS):** Classification and nomenclature of drugs, Theory of drug action and factors affecting the drugs, Types of drugs, Antimalarial drugs	45L	**50**	**4**
CEM-395	**Organic Chemistry Project I**	16 Weeks	**100**	**8**
	Total Marks		300	
	Total Credit			24

4th Semester: Physical Chemistry Spl.				
Paper	Course	**Duration**	**Marks**	**Credit Point**
CEM 401	**Advanced Spectroscopy-II**	45L	**50**	**4**
Unit I	NMR spectroscopy I			
Unit II	NMR spectroscopy II			
Unit III	Mass spectroscopy			
Unit IV	Combined applications of spectroscopic techniques			
Unit V	CD, ORD, MossBauer spectroscopy			
CEM 402	**Advanced Physical Chemistry III**	45L	**50**	**4**
Unit I	Quantum mechanics of many electron systems I			
Unit II	Atomic Spectroscopy			
Unit III	QM of diatomic molecules			
Unit IV	QM of many electron systems II			
Unit V	Application of perturbation theory			
CEM 403	**Advanced Physical Chemistry IV**	45L	**50**	**4**
Unit I	Chemical kinetics II			
Unit II	Chemical kinetics III			
Unit III	Macromolecules			
Unit IV	Bioploymers			
Unit V	Advanced electrochemistry			
CEM 404	**Chemistry in technology**	45L	**50**	**4**
Unit I	Biophysical Chemistry			
Unit II	Instrumental analysis: theory and practices			
Unit III	Chemical toxicology			
Unit IV	Corrosion technology			
CEM 495	**Physical Chemistry Project II**	16 Weeks	**100**	**8**
	Total Marks		300	
	Total Credit			24

4th Semester: Inorganic Chemistry Spl.				
Paper	Course	**Duration**	**Marks**	**Credit Point**
CEM 401	**Advanced Spectroscopy-II**	45L	**50**	**4**
Unit I	NMR spectroscopy I			
Unit II	NMR spectroscopy II			
Unit III	Mass spectroscopy			
Unit IV	Combined applications of spectroscopic techniques			
Unit V	CD, ORD, MossBauer spectroscopy			
CEM 402	**Advanced Inorganic Chemistry III**	45L	**50**	**4**
Unit I	Magnetochemistry			
Unit II	Metal carbonyls and clusters			
CEM 403	**Advanced Inorganic Chemistry IV**	45L	**50**	**4**
Unit I	Inorganic reaction mechanism			
Unit II	Analytical chemistry			
CEM 404	**Chemistry in technology**	45L	**50**	**4**
Unit I	Biophysical Chemistry			
Unit II	Instrumental analysis: theory and practices			
Unit III	Chemical toxicology			
Unit IV	Corrosion technology			
CEM 495	**Inorganic Chemistry Project II**	16 Weeks	**100**	**8**
	Total Marks		300	
	Total Credit			24

4th Semester: Organic Chemistry Spl.				
Paper	Course	**Duration**	**Marks**	**Credit Point**
CEM 401	**Advanced Spectroscopy-II**	45L	**50**	**4**
Unit I	NMR spectroscopy I			
Unit II	NMR spectroscopy II			
Unit III	Mass spectroscopy			
Unit IV	Combined applications of spectroscopic techniques			
Unit V	CD, ORD, MossBauer spectroscopy			
CEM 402	**Advanced Organic Chemistry III**	45L	**50**	**4**
Unit I	Organic photochemistry I & II			
Unit II	Biologically active molecules			
Unit III	Vitamins and coenzymes			
Unit IV	Heterocyclic chemistry			
CEM 403	**Advanced Organic Chemistry IV**	45L	**50**	**4**
Unit I	Stereochemistry III			
Unit II	Stereochemistry IV			
Unit III	Stereochemistry V			
Unit IV	Stereochemistry VI			
Unit V	Stereochemistry VII			
CEM 404	**Chemical principles in food science and technology:** Storage and handling of fresh and processed food and vegetables, dairy processing, cereal processing, fats and oils, quality control and food safety.	45L	**50**	**4**
CEM 495	**Organic Chemistry Project II**	16 Weeks	**100**	**8**
	Total Marks		300	
	Total Credit			24

SEMESTER-I

CEM – 101: Physical Chemistry-I Marks: 50 Credits: 4 Classes: 45L

Unit-1: Mathematical Preliminaries & Quantum Mechanics-I Dr. Nabakumar Bera (NKB)

Elements of Calculus, Extremum Principles, Constrained Extremization, powerer Series, Fourier transformation, Vectors and vector space, Differential equations.

Postulates and their analysis, Properties of Operators and Commutators, angular momentum operator, Equation of Motion, Stationary States, Ehrenfest‟s Theorems, Bound status: box with infinite and finite walls.

Unit-2: Thermodynamics: Dr. Pradipta Ghosh (PG)

Chemical potential, Thermodynamic properties of gases with special reference to real gases in pure state and mixtures.

Thermodynamics of ideal and non-ideal binary solutions: excess functions; partial molar properties. Gibbs Duhem equation: uses. Fugacity, Different scales of activity co-efficients for solutes and solvents.

Unit-3: Statistical Machanics - I: Dr. Nabakumar Bera (NKB)

Phase cell, macrostate, microstate, thermodynamical probability and entropy, Maxwell-Boltzmann, Bose-Einstein and Fermi-Dirac statistics. PF for atoms and diatoms (translational, rotational, vibrational and electronic), Gibbs paradox.

Unit: 4: **Fundamentals of Nanoscience and technology** Dr. Tapas Kumar Adalder (TA)

Introduction and fundamentals of nanoscience and technology; synthesis, Characterization and properties of nanomaterials; Application of nanomaterials.

Unit: 5: **Principle of Molecular Spectroscopy-I** Dr. Pradipta Ghosh (PG)

General introduction, nature of electromagnetic radiation, shapes & width of spectral lines, Intensity of spectral lines, Fourier transform.

Microwave Spectroscopy: Moment of Inertia and Classification of molecules, Diatomic molecule as rigid rotator, non rigid rotator, Hyperfine Structures, Stark Effect and determination of Dipole moment. Infrared Spectroscopy: Vibrational Spectra of diatomic Molecules, Harmonic Oscillator model, Anhermonic oscillator model, Rotational Vibrational spectra of diatomic molecules.

CEM 102: Organic Chemistry –I Marks: 50 Credits: 4 Classes: 45L

Unit-01

Pericyclic reaction I : Dr. Tapas Kumar Adalder (TA)

Pericyclic reactions characteristic features, conservation of orbital symmetry MO of different polyenes, electrcyclic, cycloaddition, sigmatropic reactions, Rationalisation of different example with the basis of frontier orbital interaction, Wood Word Hofmann symmetry rules for pericyclic reactions, exceptions to symmetry rules, correlation diagram of different perecyclic reactions. Problems relating to these reactions.

Unit-02

Organic transformations/ Reagent Chemistry/Synthesis-I: Dr. Ansuman Bej (AB)

Cation-olefin cyclization reaction: application to the synthesis of tritepenes: biogenetic isoprene rule: monocyclic, bicyclic, tricyclic, tetracyclic and pentacyclic ring systems. Fragmentation reaction, Remote functionalization: biomimetic reactions / template effect, examples. Functional groups inter conversion. Multicomponent reactions: Definition, early examples, Passerine reaction, Ugi reaction. Olefin metathesis reaction: Definition, Ring closing metathesis reaction, examples. Phase transfer catalysis.

Unit-03

Natural products-Terpenoids: Dr. Dilip Rout (DR)

Terpenoids: Isoprene rules, acyclic monoterpenoids, cetral geraniol neral, linalool monocyclic monoterpenoids; -terpeinol, structure elucidation, synthesis and biogenesis. Higher terpenoids: sesqui-, di-, sester-, tri-, tetra- terpenoids.

Unit - 04

Natural Products - Alkaloids: Dr. Dilip Rout (DR)

Alkaloids: Phenyl ethyl amine, quinine, nicotine: structure, synthesis, biogenesis.

Unit - 05 Dr. Susovan Mandal (SM)

Retrosynthetic analysis-I: Organic Synthesis Strategy, the disconnection approach.

CEM 103: Inorganic Chemistry-I Marks: 50 Credits: 4 Classes: 45L

Unit- 1: Symmetry and Group theory-I Dr. Nabakumar Bera (NKB) & Smt. Sanchayita Adikari (SA)

Groups and their properties- the concept of groups; subgroups, classes and the related theorems; commutative (abelian) groups and cyclic groups and their examples; group multiplication tables and the rearrangement theorem. Symmetry elements and operations, products of symmetry operations, equivalent symmetry elements and equivalent atoms, symmetry in platonic solids, identification of point groups, Symmetry of C_{60} fullerenes, Crystallographic symmetry: 32 crystal classes, Hermann–Mauguin (HM) notations, optical activity and dipole-moment on the basis of point group symmetry; similarity transformation and the invariance of characters; block diagonalisation; direct product of matrices and their characters etc. Matrix representation of symmetry operations, characters of symmetry operations in a representation, invariance of character under similarity transformation, the row / column orthogonality of characters, reducible and irreducible representations, the "Great Orthogonality Theorem" (without derivation) and its corollaries.

Unit- 2: Solid state Chemistry and crystallography Dr. Tarun Mistri (TM) & Dr. Pradipta Ghosh (PG)

Defects in solids, line and plane defects. Deterination of equilibrium concentration of Schottky and Frenkel defects, Stoichimetric imbalance in crystals and non-stoichiometric phases, Color centres in ionic crystals. Band theory, band gap, metals, insulators, semiconductors (intrinsic and extrinsic), hopping semiconductors, rectifiers and transistors. Bonding in metal crystals: Free electron theory, electronic specific heat, Hall effect, electrical and thermal conductivity of metals, Superconductivity, Meissner effect, basic concepts of BCS (Bardeen-Copper-Schriffer) theory. TM

Crystalline solid: single crystal and polycrystal (twinning problem) lattice, unit cell-primitive and non-primitive unit cells, unit cell parameters and crystal systems. Space group- Hermann–Mauguin notations, space group in triclinic and monoclinic system. Indexing of lattice planes, Miller indices. Bragg's equation, reciprocal lattice and its relation to direct lattice; Bragg's reflection in terms of reciprocal lattice-sphere of reflection and limiting sphere; relation between d_{hkl} and lattice parameters. PG

Unit: 3 Bioinorganic chemistry-I: Dr. Tarun Mistri (TM)

Essential elements in Biology (major and trace), beneficial and toxic elements, role of metal ions. Bioenergetic principle and role of ATP. O_2 – uptake proteins: hemoglobin, myoglobin, hemerythrin and hemocyanin, structure, function and model study. Electron transport protein: Fe-S proteins, cytochromes. Metal ions transport and storage proteins: ferritin, transferin, ceruloplasmin. Transport across biological membrane - Na^+-K^+-ATPase, ionophores. Hydrolytic enzymes: carbonic anhydrase, carboxy peptidase, urease. Metal dependent diseases: Wilson's disease, Alzheimer disease. Transition metal complexes as drugs.

CEM 104: FOOD PROCESSING AND PRESERVATION-I and COMPUTER BASICS
Marks: 50 Credits: 4 Classes: 45L

UNIT-I: Dr. Prasanta Patra (PP)
Constituents of Food: **Water**; Water in foods and its properties, **Carbohydrates**; Sources and physico-chemical and functional properties, **Proteins**; Sources and physico-chemical and functional properties, Purification of proteins, Common food proteins, **Lipids**; Sources and physico chemical and functional properties, PUFA (Poly-unsaturated Fatty Acids), Lipids of biological importance like cholesterol and phospholipids, Hydrogenation and rancidity of lipids, Saponification number, iodine value of lipids, **Vitamins and Minerals**; Sources, classification and structures of minerals & vitamins, Effect of processing and storage of vitamins, Pro vitamins A & D; Vitamins as antioxidants
Food Pigments & Flavouring Agents: Importance, types and sources of pigments, their changes during processing and storages

UNIT-II: Dr. Prasanta Patra (PP)
Introduction to food microbiology- definition, historical development and significance, Factors influencing the growth and survival of microorganisms in foods, Role of microbes in fermented foods and genetically modified foods, Food spoilage, Types and causes of food spoilage.
Microbiology of milk & milk products like cheese, butter, ice-cream, Microbiology of meat, fish, poultry & egg and their products, Microbiology of cereal and cereal products like bread, confectionary etc.

UNIT-III: Dr. Prasanta Patra (PP)
Food preservation: Principles and methods: **Canning;** Preservation principle of canning of food items, thermal process time calculations for canned foods, spoilage in canned foods; **Dehydration and drying of food items;** Water activity of food and its significance in food preservation, IMF, **Low temperature preservation;** freezing and cold storage, cold chain, **Preservation by fermentation**; curing and pickling, **Use of preservative in foods**; chemical preservative, biopreservatives, antibiotics, lactic acid bacteria, **Hurdle technology**

Unit –IV: Sri Sandip Sarkar (SS), Dept. of Mathematics
Computer Basics-I: Block diagram of a computer, Functions of the Different Units, Input unit, Output unit, Memory unit, CPU (ALU+CU), Input Devices: Keyboard, Mouse, Data Scanning devices image scanner, OCR, OMR, MICR, Barcode reader, card reader. Output Devices: Monitor, Printer-laser printer, dot-matrix printer, inkjetprinter, Projector. Memories, Registers, Cache Memory, Primary memory, RAM, ROM, Secondary Memories - Hard disk, Structure of a hard disk, concept of tracks, sectors, clusters, cylinders. Software: System Software - Operating System - Functions of O/S, Types of O/S, Program Language Translators, Assembler, Compiler, Interpreter, Utility Programs, Application Software, Computer Languages - Machine language, . Assembly language, High-level language, Data storage: The decimal number system, the binary number system, hexadecimal notation, octal number system. Conversion from one number system to another number system, Codes, ASCII, BCD etc. Arithmetic Operation for Binary Numbers. Representation of numbers in 1's and 2's Complement method. Subtraction using 1's and 2's Complement method.

Unit V: Sri Sandip Sarkar (SS), Dept. of Mathematics

Computer Basics – II: Data Manipulation: Logical Operations: AND, OR, NOT, NAND, NOR, EX-OR, EX-NOR. Logic gates with the truth table, Universal Gates, Representation of function using gates.

Boolean Algebra & Logical Gates- Basic Definitions Boolean Algebra, Theorems of Boolean Algebra. Boolean Functions. Simplification of Boolean Function- Karnaugh Map Method 3 variable, 4 variable, 5 variable Map. Sum Of Product Product of Sum, Don't care
Combinational Circuits-Design Procedure Adders. Sequential Circuits - Flip-flops.

Text Books/References:

1. Food Science, 5th Ed, 1997, B. Srilakshmi, New Age International (P) Ltd, New Delhi.
2. N.N. Potter CBS Publishers and Distributors, Delhi, 5th Ed, 1996 Food Science.
3. Food Processing and Preservation by B. Sivasankar

CEM 195: Inorganic Chemistry (Practical) 8 weeks

Dr. Tarun Mistri (TM) & Smt. Sanchayita Adikari (SA)

1. Quantitative analysis

1A. Gravimetric estimation of Zn(II) as $Zn(NH_4)(PO_4)$
1B. Gravimetric estimation of Cu(II) as CuSCN
1C. Gravimetric estimation of Ni(II) as $Ni(DMGH)_2$
1D. Gravimetric estimation of Ba(II) as $BaSO_4$
1E. Gravimetric estimation of Pb(II) as $(Pb)_3(PO_4)_2$
1F. Volumetric estimation of Mn(II)/Fe(III)
1G. Volumetric estimation of Cr(VI)/ Fe(III)
1H. Volumetric estimation of Cu(II)/ Fe(III)
1I. Volumetric estimation of Cu(II)/Cr(VI)

2. Analysis of Metals and Alloys

2A. Quantitative estimation of Zn(II) and Cu(II) in brass sample by volumetry and gravimetry
2B. Quantitative estimation of iron in cast iron and steel.

3. **Analysis of Ores and Minerals**

3A. Quantitative estimation of manganese in pyrolusite
3B. Quantitative estimation of $CaCO_3$ and $CaCO_3$ in dolomite

4. **Equilibrium studies on inorganic reactions**

4A. Determination of composition of Fe(III)-sulfosalicylate complex in solution by Mole-Ratio method.
4B. Determination of composition of Fe(II)-1,10-phenanthroline complex in solution by Mole-Ratio method.
4C. Determination of composition of Fe(III)-sulfosalicylate complex in solution by Slope-Ratio method.
4D. Determination of composition of Fe(II)-1,10-phenanthroline complex in solution by Slope-Ratio method.
4E. Determination of composition of Fe(III)-sulfosalicylate complex in solution by Job's method of continuous variation.

4F. Determination of composition of Fe(II)-1,10-phenanthroline complex in solution by Job's method of continuous variation.

5. **Spectrophotometric Estimation**

5A. Colourimetric estimation of Fe(III) (as thiocyanate complex)

5B. Colourimetric estimation of Fe(II) and Fe(III) in a mixture as Fe(II)-1,10-phenanthroline complex.

6. **Synthesis and Characterization of inorganic compounds**

6A. Reinkey's salt

6B. $[Co(NH_3)_6]Cl_3$

6C. $[Cu(NH_3)_4(SO_4)(H_2O)]$

6D. $[Co(NH_3)_5Cl]Cl_2$

6E. $[Ni(en)_2]Cl_2$

6F. $K_3[Fe(ox)_3]$

6G. $K_3[Cr(ox)_3]$

6H. $[Co(NH_3)_6]Cl_3$

6I. $[Cu(NH_3)_4(SO_4)(H_2O)]$

6J. Crome alum $[K_2SO_4,Cr_2(SO_4)_3,24H_2O]$

CEM 196: FOOD PROCESSING, PRESERVATION & PACKAGING LAB (Practical) (8 weeks)

Dr. Dilip Rout (DR) & Dr. Susovan Mandal (SM) Full Marks : 50

EXPERIMENTS

I: Preparation of jams, jellies, syrups, squashes

II: Preparation of mixed fruit juices: Aloe vera mixed with lichi, mango, pine apple, water melon, etc.

III: Estimation of Food Values (carbohydrate, fat, protein, vitamins) and Food Safety Test.

IV: Preservation of processed food

V: Packaging of processed and preserved food

VI: Study of Rheology of Jam, Jelly and sauce

VII: Value addition in food products

REFERENCES

1. Rahman, M.S. "Handbook of Food Preservation", Marcel Dekker, 1999.

2. Ranganna, S. "Handbook of Canning and Aseptic Packaging" Vol. I, II & III, Tata McGraw – Hill, 2000.

SEMESTER-II

CEM 201: Physical Chemistry –II **Marks: 50** **Credits: 4** **Classes: 45L**

Unit-1: Quantum Mechanics-II Dr. Nabakumar Bera (NKB)

Harmonic Oscillator (Wave function and Operator methods), Hydrogen atom Problem: Cartesian and Polar coordinates. Centre of Mass and relative coordinate, Spherical harmonics. Real and complex orbital, Role of constant of motion.

Approximate method: Variational principle

Unit-2: Chemical Kinetics-I Dr. Nabakumar Bera (NKB)

Kinetics of Fast reactions: flow method, relaxation method, flash photolysis. Oscillatory reactions: Observation and mechanism. Autocatalytic reaction.

Kinetics of redox reaction: inner sphere and outer sphere mechanism.

Reactions between ions: influence of solvent dielectric constant (double sphere model), single sphere activated complex model, influence of ionic strength, Enzyme catalysis and Enzyme inhibition (Competitive inhibition, Uncompetitive inhibition, mixed inhibition)

Unit-3: Electrochemistry Dr. Pradipta Ghosh (PG)

Debye Huckel theory, its modifications and extensions, mean ionic activity co-efficients, ion association, and precise determination of dissociation constants of weak electrolytes by method of emf and conductance measurements, ion-solvent interaction and solvation number. Non stationary processes in electrolytic solutions, Onsager conductance equation, effect of high electric field and frequency on ion conductance.

Unit-4: Molecular Spectroscopy-II Dr. Pradipta Ghosh (PG)

Raman Spectroscopy: Introduction. Classical Theory of Raman Scattering, Q.M Picture of Raman Scattering, Characteristic parameters of Raman lines, Pure Rotation and Vibrational Raman spectra, Basic Principles of a Raman spectrometer, Application of Raman Spectroscopy.

Electronic Spectroscopy: Fluorescence, Phosphorescence and nonradiative processes.

Unit-5: Surface Chemistry Dr. Nabakumar Bera (NKB) & Dr. Pradipta Ghosh (PG)

Curved surfaces: Young-Laplace and Kelvin equations PG

Adsorption on solids: BET eqn. Micelles, reverse micelles; micellization equilibrium; thermodynamics of micellization; micro and macro emulsions. NKB

CEM 202: Organic Chemistry - II **Marks: 50** **Credits: 4** **Classes: 45L**

Unit - 01

Pericyclic reaction I : Dr. Ansuman Bej (AB)

Perturbation molecular orbital theory (PMO), energy diagram of ethylene and butadiene system with different substitutions and study of their cycloaddition reactions, orbital coefficient and diagram of polyene systems with various substitutions. Regioselectivity, Periselectivity and Site selectivity, secondary interactions in pericyclic reactions, cheletropic reactions. Problems relating to these reactions.

Unit-02

Organic transformations/ Reagent Chemistry/Synthesis-II: Dr. Ansuman Bej (AB)

Oxidations reactions: Hydroxylation reagents, use of peroxy acids, Woodward prevost hydroxylation, Sharpness asymmetric expoxidation, AD-mix, Transformation of expoxides. Organophosphorus reagents, organo sulfer reagents, organo boranes, organo silanes, organostannanes, metal hydrides, Birch reduction, Bayer Villiger reactions, chichibabin reaction, Merrifield resin: solid phase synthesis.

Retro synthetic analysis: disconnection approach. Examples to illustrate disconnection approach in organic synthesis.

Unit 03 Dr. Tapas Kumar Adalder (TA)

Retro synthetic analysis-II: disconnection approach. Examples to illustrate disconnection approach in organic synthesis.

Unit 04

Stereochemistry I: Dr. Susovan Mandal (SM)

Different projection formulae and their interconversions. Conformational and configurational enantiomers. Stereochemical nomenclatures : (E, Z), chiral centre, chiral axis, chiral plane, helicity, threo-erythro, pref-parf, chiral simplex. Stereogencity and chirotopicity. Symmetry and molecular chirality. Stereochemical features : cyclohexane and its derivatives conformation and physical properties. Computation of stereoisomers of different systems. Conformation and relative reactivity of diastereomers. 2-, 3-, and 4- Alkyle ketone effects.

Unit 05

Stereochemistry II: Dr. Susovan Mandal (SM)

Prochirality and Prostereoisomerism. Topicity and Reactivity. A symmetric synthesis : Addition of a chiral reagents to chiral ketones and aldehydes, models of stereochemical control : Cram, Felkin and Karabatsos. Atropisomerism Molecular rearrangements with Neighbouring group participations. Stereospecific and stereoselective reactions. Sharpless expoxidation.

CEM 203: Inorganic Chemistry - II **Marks: 50** **Credits: 4** **Classes: 45L**

Unit: 1: Organometallic chemistry –I Dr. Tarun Mistri (TM)

Application of 18-electron and 16-electron rules to transition metal organometallic complexes, Ligands in organometallic chemistry; Synthesis, bonding and reactivity of Metal-alkyl, -alkene, -alkyne, -allyl, -carbene, -carbyne and -carbide complexes, Agostic interaction, Stereochemical non-rigidity and fluxional behaviour of organometallic compounds with typical examples.

Unit: 2: Group theory-II Dr. Tarun Mistri (TM) & Smt. Sanchayita Adikari (SA)

Character tables (C_{2v}, C_{3v}, C_{4v}, D_4), representation for cyclic groups, wave functions as bases for Irreducible Representations, the standard reduction formula; the direct product representation and its decomposition, identifying nonzero matrix elements, spectral transition probabilities, allowedness - forbiddenness of n-π* and π-π* transitions, symmetry of normal modes, normal mode analysis, selection rules for IR and Raman transitions. Projection operator (without derivation), use of the projection operator to form symmetry adapted linear combination (SALC) of simple system.

Unit: 3: Chemistry of p and d-block elements Dr. Tarun Mistri (TM) & Smt. Sanchayita Adikari (SA)

Boron cluster classification, skeletal electron counting. Boron hydrides: boranes, structure, bonding (MO description of B_2H_6 and $B_2H_6^{2-}$) and Lipscomb's topology, 'styx' system of numbering, nomenclature; carboranes, metalloboranes, metallocarboranes-synthesis and structure; Wade's rules, boron compounds of potential medicinal interest; boron neutron capture theory (BNCT). SA

Chemistry of Ti -Zr- Hf, V-Nb-Ta, Cr-Mo- W, Mn-Tc-Re, Ru-Rh-Pd, Os-Ir-Pt with reference to electronic configuration, oxidation states, coordination number, aqueous chemistry, redox behavior. Iso- and heteropolyoxometalates with respect of V, Mo and W: synthesis, reactions, structures, uses. Dinitrogen and dioxygen complexes: synthesis, structure, bonding and reactivity. Bonding and properties of molybdenum blue, tungsten blue, ruthenium blue, platinum blue, tungsten bronze, ruthenium red. Creutz-Taube complex, Vaska's complex. Nb, Ta halide clusters. Electronic configuration, oxidation state and comparative study Stabilization of uncommon oxidation states of transition metals by complex formation -Fe(IV), Co(IV), Ni(III), Ru(IV), Os(IV), Pd(III / IV), Pt(III), synthesis and structures. TM

CEM 204: Nanotechnology: Principles and Practices (Elective Course) **Marks: 50** **Credits: 4**
Dr. Tapas Kumar Adalder (TA) **Classes: 45L**

Unit I:

Introduction: Bulk vs. Nano, Geometric structure, Magic numbers, co-ordination number of small clusters.

Unit II:

Synthesis of Nanomaterials: Physical methods, Chemical methods, Biological methods.

Properties of Nanomaterials: Mechanical properties, structural properties, melting of nanoparticles, electrical conductivity, optical properties, magnetic properties.

Unit III:

Analysis techniques:

Microscopes: Optical microscopes, Electron microscopes, Scanning electron microscope, Transmission electron microscope, Scanning probe microscope, Scanning tunneling microscope, Atomic force microscope, XRD, Spectroscopies: UV-VIS-NIR, Infrared (FTIR), Photo luminescence, XPS (X-ray photo electron spectroscopy), Anger electron spectroscopy.

Unit IV:

Application of Nanotechnology:

Electronics, Energy, Automobiles, Sports and Toys, Textiles, Cosmetics, Domestic applications, Biotechnology and medical field, space and Defense, Nanotechnology and environment.

CEM 295: Organic Chemistry Practical **Marks: 50** **Credits: 4**

Dr. Susovan Mandal (SM)

1. Liquid Sample

Qualitative analysis (color, odour, solubility etc.); *Thin Layer Chromatography (TLC, preparation of TLC plates, analysis),* boiling point determination, *Assign* ^{1}*H-NMR,* ^{13}*C-NMR spectra,* Identify the liquid substance.

[15]

2. Extraction of Renewable chemicals

Take a particular part of a plant such as fruit, leaf, bark, heavy wood, etc. Weight it. Extract with a particular solvent. Remove the volatiles. Purify. Weigh the product. Calculate % yield, Analyze the product by Thin Layer Chromatography, calculate R_f value. UV-VIS spectral characterizations: Measure $\lambda_{max,}$ ε_{max} and explain. Submit the product with proper label.

[15]

OR

2. Preparation

Preparation of pure organic compound single-step or two step procedure and submission of crystallized product: Table Preparation; Weigh the compound, calculate theoretical yield, prepare the compound, weigh the product, calculate % yield, crystallize, check M.P., submit crystallized product.

3. Sessional Work

To be awarded by the class teacher on the basis performance of the students during the course work.

[10]

4. Viva Voce

To be jointly conducted by the external and internal examiners during the examination.

[10]

CEM 296: Physical Chemistry Practical Marks: 50 Credits: 4

(One day examination - duration 6 hours, Full Marks = 50)

Dr. Nabakumar Bera (NKB)

1. List of Experiments:

1. Kinetics of Inversion of Cane-sugar by Polarimeter /
2. Determination of concentration of Glucose-fructose in a mixture using polarimeter
3. Conductometric determination of concentrations of KCl, HCl and NH4Cl in a mixture.
4. Verify the Onsagar equation using KCl, K_2SO_4 and $BaCl_2$ as electrolytes and determine their Λ_0 values.
5. Determination of CMC of a surfactant in aqueous solution by conductometric method.

6. Potentiometric titration of halide mixture (Chloride, Bromide and Iodide).

7. Determine the E0 value of Ag+/Ag electrode and activity coefficients of different aqueous AgNO3 solutions potentiometrically.

8. Determine the standard potential of *Fe(CN)6+3-/ *Fe(CN)6+4- electrode by potentiometer.

9. Determine the dissociation constants (K1, K2, and K3) of H3PO4 by pH meter.

10. Study the kinetics of Iodination of acetone spectrophotometrically.

11. Determination of composition of complexes (Ferric-salicylate complex/Ferrous-orthophenanthroline complex) by Job's method.

12. Determine the rate constant and the order of the reaction of KBrO3 & KI in acid medium.

13. Determine the order and rate constant of the reaction between K2S2O8 & KI and study the influence of ionic strength on the rate constant.

14. Study of the kinetic of alkaline hydrolysis of crystal violet. Determine the order with respect to alkali and salt effect on the system.

14. Spectroscopic experiments relating to quenching of fluorescence
15. Experiment for the measurements of activation barrier of some model chemical reactions

2. Sessional Work:

To be awarded by the class teacher on the basis performance of the students during the practical classes.

5

3. Viva Voce:

To be jointly conducted by the external and internal examiners during the examination.

10

SEMESTER-III

CEM 301: Advanced Spectroscopy-I (Common Paper: Physical/Inorganic/Organic)

Marks: 50 Credits: 4 Classes: 45L

Unit: 1

Photophysical processes: Dr. Tarun Mistri (TM)

Photophysical processes of unimolecular processes, Delayed fluorescence, Kinetics of bimolecular processes: collision quenching, Stern-Volmer equation, Concentration dependence of quenching and excimer formation, Excited state electron transfer processes: Exciplex, Twisted intramolecular charge transfer processes, proton couple electron transfer processes (both intra and intermolecular).

Unit: 2

Laser and its applications: Dr. Nabakumar Bera (NKB)

General feature and properties of LASER, Method of obtaining population inversion, Laser cavity modes, Q-switching, Mode locking, Example of LASER: Ruby laser, Nd-YAG laser, diode laser, He-Ne laser, N_2 laser, Ar laser, excimer and exciplex laser, Dye laser.

Unit: 3

EPR spectroscopy Dr. Tarun Mistri (TM)

Principle, spin Hamiltonian (comparison to NMR spectra), energy of spinning electron in a magnetic field, EPR-instrumentation, representation of EPR spectrum, X-band and Q-band spectra, line width, hyperfine splitting, magnetically equivalent and nonequivalent sets of nuclei, *g*-anisotropy, spectra of simple organic free radicals: expected number of lines, intensities. Spectra of transition metal complexes, metal hyperfine anisotropic spectra, zero-field splitting, application: determination of oxidation state of metal ion in samples.

Unit: 4

PES and NQR spectroscopy Dr. Tarun Mistri (TM) & Dr. Nabakumar Bera (NKB)

Photoelectron spectroscopy: Photoexcitation and photoionization, core level (XPS, ESCA) and valence level (UPS) photoelectron spectroscopy, XPS and UPS experiments, chemical shift, detection of atoms in molecules and differentiation of same elements in different environments form XPS, information about the nature of molecular orbitals from UPS, UPS of simple diatomic molecules e.g. N_2, O_2, CO, HCl etc. Principle of NQR, nuclear quadrupole coupling constant, structural information from NQR spectra.

CEM 302: Advanced Physical Chemistry-I (Physical Spl.) Marks: 50 Credits: 4

Classes: 45L

Unit-1: Matrix mechanics: Dr. Nabakumar Bera (NKB)

Basis and representations, Elementary matrix properties, Unitary and similarity transformation in quantum mechanics, Energy representations, angular momentum matrices, the pauli spin matrices. Matrix eigen value problem. Linear variational principle and matrix.

Unit-2: Stationary perturbation theory Dr. Pradipta Ghosh (PG)

Perturbation theory: Derivation of time independent non-degenerate perturbation equations, first order non-degenerate and degenerate perturbation theory, Applications: anharmonic oscillator, non rigid rotator, He atom, Stark effect, Zeeman effect

Unit-3: Semiclasical treatment of radiation-matter interaction Dr. Pradipta Ghosh (PG)

Theoretical basis of interaction of radiation with matter: time dependent perturbation theory, Harmonic perturbation and transition probabilities, Einstein's A& B co-efficient, LASER and MASER

Unit-4: Semiempirical methods of Quantum Chemistry: Dr. Pradipta Ghosh (PG)

The Hückel Molecular orbital Theory: Mathematical formalism of Hückel theory, Hückel MO's and orbital of 1,3-Butadine, Nodal properties of the π-MO of butadiene, Alternate and non-alternate conjugated hydrocarbons, Analytical expression for Hückel MO's and orbital energies in linear and cyclic polyenes. Delocalization energy, excitation energy and Ionization energy of conjugated hydrocarbons, charge density, Bond order and free valence index derived from Hückel MO's.

Unit-5: Group Theory and Quantum Mechanics: Dr. Nabakumar Bera (NKB)

Quantum mechanics and group representation theory, Direct product representation, Vanishing of quantum mechanical integral, Transition probability, Selection Rules, Projection operation, symmetry adapted linear combination of atomic orbitals. Application of group theory to molecular vibrations, Normal modes, Vibrational transitions, IR and Raman Spectra and Selection rule, Application of group theory to Ligand and crystal field theory, Symmetry and chemical reactions; Woodward –Hoffmann Rule.

CEM 302: Advanced Inorganic Chemistry-I (Inorganic Spl.) Marks: 50 Credits: 4

Classes: 45L

Unit: 1

Organometallic chemistry –II and catalysis Smt. Sanchayita Adikari (SA)

Chemistry of transition metal complexes with cyclic polyenes: 3-6 membered ring systems. Sandwitch and non sandwitch complexes. Organometallic chemistry of heterocyclc ligands (N,B,O). Multidecker sandwitch complexes. Bioorganometallic chemistry, Organometallic polymers, Main group organometallic chemistry.

Terminology in catalysis: TO, TON, TOF. Unique reactions in organometallic chemistry and catalysis: Coordinative unsaturation, Substitution, Oxidative addition, Insertion (migration), Isomerization, Reductive elimination; Catalytic converters; Alkene hydrogenation, Water gas shift reaction, Fischer Tropsch process. Hydroformylation (Oxo process), Carbonylation of olefins, Monsanto's acetic acid synthesis, Wacker oxidation (Pd-catalysed), Polymerization of olefins, Ziegler-Natta catalyst.

Unit: 2

Chemical applications of group theory Smt. Sanchayita Adikari (SA)

Splitting of orbitals and free ion terms in weak crystal fields, symmetries and multiplicities of energy levels in strong crystal fields, correlation diagram, Orgel diagram, Tanabe-Sugano diagrams, Effect of lowering of symmetry on the orbitals and energy levels, correlation table. Vanishing of quantum mechanical integral, transition probability, selection rules. Justification of Laporte selection rule, vibronic coupling and vibronic polarization, polarization of electronically allowed transitions.

Symmetry adapted linear combination of atomic orbitals, construction of□□ MO for different system; LCAO-MO approximations Huckel theory for conjugated system. Symmetry of hybrid orbitals. Determine the symmetry and combinations of Ligand group Orbitals (LGO) and metal orbitals in octahedral, square planar, tetrahedral and other ligand environments using of projection operator. Construction of qualitative MO energy level and interaction diagram on the basis of symmetry considerations only. Drawing of LGO and MO diagrams. Application to IR and Raman spectra. Symmetry and chemical reactions; Woodward-Hoffmann rule.

CEM 302: Advanced Organic Chemistry-I (Organic Spl.) Marks: 50 Credits: 4

Classes: 45L

Unit-01: Pericyclic reaction III: Dr. Ansuman Bej (AB)

Pericyclic reactions and applications of MO theory to Organic Chemistry: Electrocyclic reactions, Sigmatropic rearrangement, cycloaddition and cycloreversion reactions, cheletropic reactions, ene reaction.

Frontier Molecular Orbital theory, concept of aromaticity of Transition States, orbital correlation diagrams, Huckel MO theory- MO's of chains and rings alternants and nonalternants.

Unit 02: Linear Free Energy Relationship-I Dr. Susovan Mandal (SM)

Linear Free Energy Relationship: Quantitative correlations of rate and equilibria. Linear free energy relationships with special reference to Hammett, Taft, Yukawa-Tauno and Grunwald-Weinstein equations.

Unit-03: Linear Free Energy Relationship-II Dr. Susovan Mandal (SM)

Application of Linear Free Energy Relationship to aromatic, aliphatic, polynuclear and hetero-aromatic systems. Multiparameter correlation reactions (elementary ideas). Electrophilic substitutions in aliphatic systems (SE1 and SE2 reactions).

Unit-04: Organometallic Chemistry Dr. Prasanta Patra (PP)

Preparation and reactions of pi-complexes, heptonumbers, rules for nucleophilic addition to complexes, applications to typical synthesis. use of transition metals : organometallics in organic synthesis.

CEM 303: Advanced Physical Chemistry-II (Physical Spl.) Marks: 50 Credits: 4

Classes: 45L

Unit-1: Solid state chemistry- I Dr. Pradipta Ghosh (PG)

Electrical conductivity of metals; free electron theory of metals (classical and quantum theory), X-ray diffraction, Laue's diffraction, atomic scattering factor and geometrical structure factor, Hall effect, Lattice vibration: phonon and exciton, superconductors.

Unit-2: Solid state chemistry- II Dr. Pradipta Ghosh (PG)

Defects in solids: Point, line and plane defects. Determination of equilibrium concentration of schottky defect and Frenkel defects, stoichiometric imbalance in crystals. Band theory: band gap, metal, insulators, semiconductors (intrinsic and extrinsic), hopping semiconductors; rectifiers and transistors.

Unit-3: Statistical mechanics-II Dr. Nabakumar Bera (NKB)

Concept of ensemble and phase space, ergodic hypothesis, Liouville's theorem, Concept of different ensembles, microcanonical ensembles: partition function, temperature, Cannonical ensemble, distribution, probability and partition function. Partition function and different thermodynamic state functions. Black body radiation.

Unit-4: Statistical mechanics III Dr. Nabakumar Bera (NKB)

Principle of equipartition of energy, chemically equilibrium system of interacting particles, imperfect gas. Grand canonical ensemble: nature of quantum particle, Bose- Einstein and Fermi-Dirac statistics, specific heat of electron gas, Bose-Einstein condensation, quantum statistics, density matrix.

Unit-5: Non-equilibrium thermodynamics Dr. Nabakumar Bera (NKB)

Characterization of non-equilibrium states: entropy production rate; Onsager reciprocal relations, principle of microscopic reversibility and detailed balancing, thermonuclear pressure difference and thermonuclear effect, cyclic and oscillatory reactions, non-linear region, higher order symmetries.

CEM 303: Advanced Inorganic Chemistry-II (Inorganic Spl.) Marks: 50 Credit:4

Classes: 45L

Unit: 1: Bioinorganic chemistry-II Dr. Tarun Mistri (TM)

Electron transfer (redox) enzyme: Catalase Peroxidase, Cytochrome P_{450}, Super oxide dismutase, Ascorbate oxidase. Molybdenum containing enzymes: Nitrate reductase, Xanthine oxidase, Sulphate oxidase. Vanadium containing protein: Amavadin, Vanadium bromo peroxidase. Vitamin B_{12}, Chlorophil (Photosystem). Metal ions in genetic information transfer: Replication, transcription and translation process. Interaction of metal ions with nucleic acids and their monomeric constituents-metal complexes of nucleosides and nucleotide.

Unit: 2: Inorganic photochemistry Dr. Tarun Mistri (TM)

Introduction to inorganic photochemistry, photophysical and photochemical process, characteristics of the electronically excited states of inorganic compounds, ligand field states, charge transfer states, Frank Condon (FC) states, THEXI and DOSENCO states, kinetics of photochemical process, photosensitization. Transition probabilities, Transition moment integral and its applications. Selections rules. Jablonski diagram, Fluorescence and phosphorescence, delayed fluorescence, quantum yield, mechanism and decay kinetics of photophysical processes. Fluorescence quenching (dynamic and static), Stern-Volmer equation. Photochromism; chemical actinometry, photochemical reaction of coordination compounds. Photochemical splitting of water, photochemical conversion and storage of solar energy, organometallic photochemistry.

CEM 303: Advanced Organic Chemistry-II (Organic Spl.) Marks: 50 Credit:4

Classes: 45L

Unit-01: Bioorganic and Supramolecular Chemistry-I Dr. Tapas Kumar Adalder (TA)

Crown ethers: discovery, nomenclature, synthesis, properties and applications. Cryptands: structures and applications. molecular recognition: definition, examples of molecular recognition utilizing H-bonding, electrostatic, solvophobic, pi-pi interaction, etc., application of molecular recognition. H-bonding in molecular organization, chiral recognition, Introduction to molecular mechanics calculation and its use in the design of molecular receptors.

Unit-02: Bioorganic and Supramolecular Chemistry-II Dr. Tapas Kumar Adalder (TA)

Cyclodextrins: Structure, property, applications. Enzymes: enzyme kinetics, mechanism; application of enzymes in organic synthesis, model enzymes based on cyclodextrins.

Unit 03: Bioorganic and Supramolecular Chemistry-III Dr. Tapas Kumar Adalder (TA)

Self-assembling systems: micelles, reverse micelles; vesicles, fibers and tubules; amphiphiles, bola-amphiphiles, Self-replication. Gels: definition, classification, examples, study of the morphology and rheology of gels, applications Chemical sensors. Photo-responsive systems, Dye sensitized solar cell, Liquid Crystals, Molecular Electronic devices, organic conductors.

Unit-04: Peptides and Nucleic acids Dr. Susovan Mandal (SM)

Peptides and Proteins: Structure and Functions; α-helix, β-pleated sheet, β-turn, 3.10 helix, Ramachandran plot. Nucleic acids: Structure and functions; replication of nucleic acids.

Unit-05: Green Chemistry Dr. Dilip Rout (DR)

The current status of chemistry and the environment. What is green chemistry? How Green and Renewables are related to sustainabilty. Principles, methodologies and techniques in Green Chemistry. Synthesis in aqueous media, Catalytic methods in synthesis, Examples of green chemistry. Future trends in green chemistry. Unconventional energy sources in synthesis: solar energy.

C-CEM 304: Pharmaceutical Chemistry (CBCS) Marks: 50 Credit: 4 Classes: 45L

Dr. Prasanta Patra (PP)

1. **Introduction of Pharmaceutical Chemistry**

   Important aspects of pharmaceutical chemistry, importance of chemistry in pharmaceuticals, some important terms used in chemistry of drugs, pharmacopeia.

2. **Classification and nomenclatures of drugs**

   Classification of drugs and their nomenclature.

3. **Theory of drug action and factors affecting the drugs**

   Theory of drug action and structure activity relation, drug receptors: isolation, modification and localization, theories related to drug action.

4. **Types of drugs**

   A. Hyponotics and sedative drugs, Anticonvulsivant and analgesic drugs, general anaesthetics and local anaesthetics, expectorant, psychoactive and nervous system stimulant drugs, antiperkinson, antihistamine, anti-inflammatory and antipyretic drugs.

   B. Antiamoebic, antifungal and antiviral drugs, antineoplastic agents, disinfectant and antiseptic, thyroid hormones and antithyroid drugs, Vitamins, sulfonamides and antibiotics.

5. **Antimalarial drugs**

   Malaria parasite and its life cycle, chemotherapy of malaria using antimalarial drugs.

CEM 395: Project (Physical/Inorganic Spl.) Full Marks = 100 Credits: 8

Duration: 16 Week

Dr. Tarun Mistri (TM) & Smt. Sanchayita Adikari (SA): Inorganic Chemistry Specialization
Dr. Nabakumar Bera (NKB) & Dr. Pradipta Ghosh (PG): Physical Chemistry Specialization

Unit 01:

Visit to an Industry and submission of a Work-Report (approximately 10 pages) on the Industry Visit **OR Review** in an area of contemporary interest: Topic to be finalized in consultation with the Incharge and a Review-Report (approximately 10 pages) has to be submitted.

[20]

Unit 02:

Research problem has to be finalized in consultation with the Incharge. The work has to be carried out under the supervision of the Incharge and Research Report of approximately 25 pages has to be submitted.

[60]

Unit 03

Seminar Lecture has to be delivered on the total work carried out. It will involve Power Point Presentation (Industry visit: 2 slides/ Review: 2 slides, Research work: 5 slides; total presentation time = 10 minutes (max.)).

[20]

CEM 395: Project (Organic Spl.) Full Marks = 100 Credits: 8 Duration: 16 Week

Dr. Dilip Rout (DR), Dr. Susovan Mandal (SM), Dr. Prasanta Patra (PP), Dr. Ansuman Bej (AB) & Dr. Tapas Kumar Adalder (TA): Organic Chemistry Specialization

Review work / Industry Visit / Field work:

Review in an area of contemporary interest: Topic to be finalized in consultation with the Incharge and a Review-Report (approximately 10 pages) has to be submitted.

OR

Industry Visit:

It will involve visit to an **Industry** and submission of a Work-Report (approximately 10 pages) on the Industry Visit

OR

Field Work, Sample Collection and submission of a Work-Report (approximately 10 pages) on the Field Work. [30]

Research Work:

Unit 01:

Research problem has to be finalized in consultation with the Incharge. The work has to be carried out under the supervision of the Incharge and Research Report of approximately 25 pages has to be submitted.

[50]

Unit 02

Seminar Lecture has to be delivered on the total work carried out. It will involve Power Point Presentation (Industry visit: 2 slides, Review: 2 slides, Research work: 5 slides; total presentation time = 10 minutes (max.)).

[20]

SEMESTER-IV

CEM 401: Advanced Spectroscopy-II (Common Paper: Physical/Inorganic/Organic)

Marks: 50 Credits: 4 Classes: 45L

Spectroscopy for Structure Elucidation

Unit-01 Dr. Ansuman Bej (AB)

Detailed study of ^{1}H NMR and preliminary aspects of ^{13}C NMR, CW and FT techniques.
Ring current: Aromaticity, Antiaromaticity, Homoaromaticity, Annulene systems.

Unit-02 Dr. Dilip Rout (DR)

NMR spectroscopy: Principles, Relaxation phenomenon, factors influencing chemical shifts and coupling constants, simplification of complex spectrum, NOE, Rotating frame of reference.

Unit-03 Dr. Dilip Rout (DR)

Mass-spectrometry combined applications of spectroscopical methods to organic molecules : Principles of Mass spectrometry, Different techniques, fragmentation modes.

Unit-04 Dr. Dilip Rout (DR)

Combined application of spectroscopic techniques (UV, IR, NMR, MS) in elucidation of structure and study of reactions of organic compounds.

Unit 05: Dr. Susovan Mandal (SM)

CD ORD and Mossbauer Spectroscopy

CEM 402: Advanced Physical Chemistry-III (Physical Spl.) Marks: 50 Credits: 4

Classes: 45L

Unit-1: Quantum mechanics of many electron systems-I: Dr. Pradipta Ghosh (PG)

PG Identical particle and Pauli's Antisymmetry principle, Slater determinant for system with more than two electrons, Eigen functions of many electron spin operator: Pure spin states, Energy expectation value of pure spin states; Orbitals in many electron atoms: The Hartree-Fock Theory, Koopman‟s theorem, The Hatree-Fock-Roothaan method for closed cell systems, Roothaan equation, Brillouin's theorem.

Unit-2: Atomic Spectroscopy: Dr. Nabakumar Bera (NKB)

NB Ground state electronic configuration of elements, Spectroscopic term symbol: LS coupling scheme, j-j coupling scheme, Electronic spectrum of many electron atoms, Zeeman Effect in many electron atoms, Electron correlation and method of configuration interaction.

Unit-3: QM of diatomic molecules: Dr. Pradipta Ghosh (PG)

PG Born – Oppenheimer approximation, Solution of electronic Schrodinger equation for molecules, Valence bond method, The molecular orbital theory, MO term symbols, Comparison of MO and VB theory.

Unit-4: QM of many electron system-II: Dr. Pradipta Ghosh (PG)

PG Basis sets for the molecular orbital calculations of polyatomic molecules, Configuration interaction. Density function theory; global reactivity descriptors: polarizability, chemical hardness, Electrophilicity; Local reactivity descriptors: Fukui functions. Calculations of polyatomic molecules, Illustrative examples of Ab initio HF and Post HF calculations, Atomic charge and bonding Indices in polyatomic molecules.

Unit-5: Applications of perturbation theory: Dr. Nabakumar Bera (NKB)

NB The Hellmann-Feynman theorem, Electrical responsive properties, perturbation treatment to, NMR spectroscopy: A-X, A2 Spin system, more than two spin system; ESR spectroscopy: total magnetic Hamiltonian of an electron, magnetic interaction in atoms, application of perturbation theory on the splitting of ESR lines on some model system.

CEM 402: Advanced Inorganic Chemistry-III (Inorganic Spl.) **Marks: 50**

Credits: 4 Classes: 45L

Unit: 1: Magnetochemistry Dr. Tarun Mistri (TM)

Magnetic properties of substances, orbital and spin angular momentum of electrons, paramagnetic moment and magnetic susceptibility. Paramagnetic and diamagnetic materials, ferromagnetism, ferrimagnetism, antiferromagnetism, magnetic permeability, magnetic susceptibility, magnetization, classical theory of diamagnetism (Langevin's theory), classical theory of paramagnetism (Langevin's theory), diamagnetism and Pascal's constants, zero-field splitting, spin-orbit coupling.

Magnetic properties and temperature – The curie and Curie-Weiss law, derivation of Curie law. Microstates, hole formalism, multiplet, multiplet width, Lande interval rule. , magnetic moments for different multiplet widths, crystal field diagram, quenching of orbital contribution, high spin/low spin equilibrium. Antiferromagnetic interactions in inorganic compounds: Mechanism like – direct interaction, superexchange interactions and elucidation with poly nuclear metal complexes as well as oxide and halide salts of transition metals. Magnetic behaviour of lanthanides and actinides.

Unit: 2: Metal carbonyls and clusters Smt. Sanchayita Adikari (SA)

Metal carbonyls: Synthesis, structure and reactivity. Low nuclearity (M_3-M_4) and high nuclearity (M_5-M_{10}) carbonyl clusters. Metal-metal bonding(MO), skeletal electron counting. Wade-Mingos-Lauher rule, isolobal analogy. Halide clusters of Nb, Ta, Mo, W, Re. Synthesis, structure and bonding. Interstitial Clusters-hydrides, carbides and nitrides. Metal-metal multiple bond. Examples, synthesis, structures and bonding(MO). Electronic transition.

CEM 402: Advanced Organic Chemistry-III (Organic Spl.) **Marks: 50**

Credits: 4 Classes: 45L

Unit-01: Organic Photochemistry-I Dr. Dilip Rout (DR)

Organic Photochemistry: Fundamental concepts, Jablonski diagram, Photochemistry of organic compounds, Norrish type- I and type II processes, Patterno Buchi reacgtion, Barton reaction, addition reaction, oxidation reaction.

Unit-02: Organic Photochemistry-II Dr. Dilip Rout (DR)

Photochemical reduction, substitution reaction, cis-trans isomerism, photochemistry of butadiene, di-pi methane rearrangement and related processes.

Unit-03: Biological Active Molecules Dr. Tapas Kumar Adalder (TA)

Antibiotics, Penicillin, Cephalosporin, streptomycin, Structure, Synthesis and biological activity to bacteria.

Unit-04: Vitamins and co-enzymes Dr. Ansuman Bej (AB)

Vitamins A1, B1, C, K coenzymes, NAD, FAD and reactivity of different Vitamin in biological reactions. Chemistry of nucleosides, nucleotides and ATP, elementary structure and role of DNA and various types of RNA‟s in protein biosynthesis.

Unit-05: Hetercycles Dr. Prasanta Patra (PP)

Heterocycles: Synthesis and Reactions: Generalized approach to the synthesis of heterocycles possessing 5-,6-, and 7- membered rings with one or two heteroatoms per ring. Reactions of heterocycles: oxidation and reduction reactions with electrophiles, nucleophiles and other reactive intermediates with typical monocyclic and fused ring systems as examples.

CEM 403: Advanced Physical Chemistry-IV (Physical Spl.) Marks: 50 Credits: 4

Classes: 45L

Unit-I: Chemicals Kinetics-II Dr. Nabakumar Bera (NKB)

Thermodynamics formulation of reaction rates, Potential energy surface, reaction co-ordinates and reaction path, BEBO method. Absolute rate theory by using partition function; statistical formulation of chemical kinetics, equilibrium formulation, derivation of expression for specific rate, entropy of activation, volume of activation. Rates of chemisorptions, rates of desorption.

Unit- II: Chemical Kinetics-III Dr. Nabakumar Bera (NKB)

Rate processes and some physical phenomena. Statistical approach to rate theory: Hinshelwood, RRK and RRKM theories. Reaction in molecular beams and shockwaves. Application of absolute reaction rate theory in viscosity. Diffusion controlled reaction (full and partial microscopic diffusion controlled). Bimolecular surface reaction: reaction between two adsorbed molecules, reaction between a gas molecule and an adsorbed molecule, inhibition, exchange reactions. TST of surface reaction.

Unit-III: Macromolecules: Dr. Nabakumar Bera (NKB)

PG

Classification of polymers, kinetics of polymerization, Molecular weight of polymers, molecular weight determination by viscosity, osmometry, light scattering, diffusion and ultracentrifugation methods. Thermodynamics of polymer solutions. Polymer conformation.

Unit-IV: Biopolymers Dr. Susovan Mandal (SM)

Structure of biomolecules i) Protein-building, peptide bonds, primary, secondary, tertiary, quaternary structure. Phi-Psi map 2) Nucleic acids- A,B,Z conformations, t-RNA conformation, carbohydrates and lipids biomembranes. a) SDS-PAGE (for proteins) b) agarose gel method (for nucleic acids). Techniques to study biomolecules: CD, ORD, Flurescence, IR and Raman spectroscopy.

Unit –V: Advanced electrochemistry Dr. Pradipta Ghosh (PG)

PG

Overvoltage, polarography, amperometric titration, basic principles of cyclic voltammetry and coulometry, polyelectrolyte. Mechanism of multi-step electrochemical reactions, hydrogen overvoltage, thermodynamics of ideally polarized electrodes, structures of metal and semiconductor-electrolyte junctions, fuel cell, photoelectrochemical cells.

CEM 403: Advanced Inorganic Chemistry-IV(Inorganic Spl.) Marks: 50

Credits: 4 Classes: 45L

Unit: 1: Inorganic reaction mechanism Smt. Sanchayita Adikari (SA)

Energy profile of reactions, discussion on general reactivity of metal complexes, inert and labile complexes, different types of mechanisms ('D', 'A', 'I_a' and 'I_d'). Techniques for experimental measurements of reaction rates, techniques for fast reaction. Substitution reactions: Application of CFT, mechanism of ligand substitution in octahedral complexes, mechanism of isomerisation and racemisation, substitution reactions in square planar complexes. *Cis*- and *trans*- effects.

Mechanism of redox reactions with reference to metal complexes. Electron transfer reactions – outer sphere and inner sphere, atom transfer, induced electron transfer reactions, two electron transfer reactions, complementary and non-complementary reactions, synthetic implications of electron transfer reactions, solid state electron transfer reactions. Electroprotic reactions. Twist mechanism of racemisation, inversion of configuration and associated process.

Unit: 2: Analytical chemistry Dr. Tarun Mistri (TM)

Electroanalytical methods: Basic principles-polarised and depolarized electrodes; diffusion current, *dropping mercury electrode* (*DME), polarographic wave;* Ilkovic equation (simplified derivation) and its significance; half-wave potential and its applications in identification of elements. Ilkovic-Heyrovsky equation, Cottrell equation. Stripping voltammetry, amperometric titration. Modern developments in polarographic techniques: Lingane's method.

Cyclic voltametry and Coulometry: Basic principle, three electrode configuration. Solvents and supporting electrolytes. Representation of cyclic voltammogram, half wave potential, irreversible, reversible and quasi-reversible redox processes. Electron transfer at a constant potential, no. of electron transfer. Application in coordination chemistry (characterization, determination of redox potential), e.g. ferrocene, Co(II)/Co(III); Ni(II)/Ni(III); Cu(I)/Cu(II); $Ru(II)(bpy)_3$

Thermal methods of analysis: Basic principles of Differential Thermal Analysis, Thermo Gravimetric Analysis. Application in coordination chemistry.

CEM 403: Advanced Organic Chemistry-IV (Organic Spl.) **Marks: 50**

Credits: 4 Classes: 45L

Unit-01: Stereochemistry-III Dr. Susovan Mandal (SM)

Conformation and Chemical Reactivity : Curtin-Hammett principle, its derivation under different conditions and applications; quantitative treatement of mobile systems, Winstein Holress equation and Eliel equation - their applications ; □□-Strain and □□-strain, allylic 1,2 - and 1, 3-strain (in pseudoallylic systems also), their applications.

Unit-02: Stereochemistry-IV Dr. Ansuman Bej (AB)

Fused ring systems, *trans* and *cis* declaims, conformation, steroid and nonsteroid conformation, symmetry, torsion angle enthalphy, entropy, free energy, substituted declains q-methyldecalins and 9,10 dimethyldecalins, decalones; conformation of cis-octalins and trans-octalins.

Unit 03: Stereochemistry-V Dr. Ansuman Bej (AB)

Sterochemistry of 4-10 membered rings, transanular reactions; perhydrophenanthrenes and perhydroanthracenesconformation, energy, symmetry and optical activity, relative stability, sterochemistry of perhydrodiphenic acids and perhydrophenanthrenes, conformations of some triterpenes.

Unit- 04: Stereochemistry-VI Dr. Tapas Kumar Adalder (TA)

Modern concepts of nucleophilic addition to carbonyl compounds, Felkin model (torsional strain) Burzi Dunitz trajectory, Cieplak model, examples.

Unit- 05: Stereochemistry-VII Dr. Susovan Mandal (SM)

Optical rotation, specific and molecular rotations-their units, Brewster rule, Lowe's rule , origin of optical rotation, circular birefrigence, optical rotatory dispersion (ORD) octant rule, axial haloketone rule-application (octant projection diagrams) ; circular dichroism (CD) differential dichronic absorption, specific ellipticity and molar ellipticity, applications of CD-helicity rule, exciton chirality (dibenzoate chirality rule) Davydor splitting-applications with different steroidal glycols.

CEM 404: Chemistry in Technology (Common Paper: Physical/Inorganic Spl.)

Marks: 50 Credits: 4 Classes: 45L

Unit 01: Dr. Nabakumar Bera (NKB)

Biophysical Chemistry: Structure and function of biomolecules: protein, nuclic acid, carbohydrates and lipids. Membrane structure, biomolecular complexes: protein-ligand, enzyme-substrate and drug-DNA. Examples, techniques for study of biomolecular structure and function.

Unit 02: Dr. Nabakumar Bera (NKB)

Instrumental Analysis: Theory and Practices: Electron Microscopy, atomic force microscopy, Polarizing optical microscopy, Circular dichroism, Calorimetry, Phase contrast microscope, dynamic light scattering, epi Fluorescence microscopy.

Unit 03: Dr. Tarun Mistri (TM)

Chemical Toxicology: Toxic Chemicals in the environment, Impact of toxic chemicals on enzymes, Biochemical effects of arsenic, cadmium, sulphur dioxide, ozone and PAN, Cyanide, pesticides, Carcinogens.

Unit 04: Dr. Tarun Mistri (TM)

Corrosion Technology: Introduction, What is corrosion, Corrosion principles: Electrochemical and other aspects of corrosion, corrosion prevention.

CEM 404: Chemical Principles in Food Science and Technology (Organic Spl.)

Dr. Prasanta Patra (PP)

Marks: 50 Credits: 4 Classes: 45L

Unit 01:

Storage and handling of fresh fruits and vegetables, pre and post harvest changes, thermal and osmotic dehydration of fruits and vegetables, canning and bottling, CAP and MAP storage, juice extraction and preparation of drinks, syrups, squashes, cordials, nectars, jam, jelly, marmalade, ketchup, pickles, chutneys, sauces, fruits juice concentrates and powders, fermented fruit and vegetable products,

Unit 02:

Science and technology of dairy processing Definition, composition of milk, Quality standards for milk, Pasteurization of milk; standardization, toning, homogenization and cream separation. Technology of dried whole milk, butter, ghee, margarine, condensed milk, fermented milk products, UHT milk, ice-cream, cheese (cheddar, cottage)

Unit 03:

Science and technology of Cereal Processing Production of milled rice, Parboiling and parboiled rice, wheat processing - classification of wheat; milling of wheat, dough mixing, types of dough and its rheology testing, production of wheat products such as bread, biscuits and cakes;

Unit 04:

Science and technology of Fats and Oils Processing ~~Fats and Oils~~ : Chemical composition, nutritional importance of dietary oils and fats, Effect of processing and storage on fats and oils (oxidative and hydrolytic rancidity), fat micelles, soap and detergency , essential fatty acids, extraction, physical and chemical refining of oils from oilseed such as mustard including winterization, bleaching and deodorization; Hydrogenation and catalysis. margarine, analytical techniques for fat and oil analysis (saponification number, acid number, iodine value, acetyl value, Reichert-Meissl number and Polenski value.Smoke, fire, flash point of oils) .

Unit 05:

Quality control and Food Safety:-Quality definition of different food products according to food laws :especially FSSAI, PFA, FPO, Essential Commodities Act, 1955, BIS, AGMARK, Classifications and functions and safety limits of food additives such as preservatives, antioxidants, colors, emulsifiers, sweeteners, buffering salts , Voluntary quality standards and certification - GMP, HACCP, GAP, ISO 9000, ISO 14000, ISO 22000; Misbranding. Adulteration in oil, dairy items and spices.

Text books/ References:

1. Robinson RK; 1996; Modern Dairy Technology, Vol 1 & 2; Elsevier Applied Science Pub.
2. Developments in Dairy Chemistry – Vol 1 & 2; Fox PF; Applied Science Pub Ltd.
3. Outlines of Dairy Chemistry, De S; Oxford.
4. Processing Fruits: Science and Technology, Vol. I, Biology Principles and Applications, L. Somogyi, Woodhead Publishing, 1st Edition, 1996.
5. Food oils and their uses; Weiss TJ;1983,AVI 6.Modern Technology in the Oils and Fats industry by S.C.Singhal, OTA(I)

CEM 495: Project (Physical/Inorganic Spl.) Full Marks = 100 Credits: 8
Duration: 16 Week

Research Work (extension from Semester III):

Dr. Tarun Mistri (TM) & Smt. Sanchayita Adikari (SA): Inorganic Chemistry Specialization
Dr. Nabakumar Bera (NKB) & Dr. Pradipta Ghosh (PG): Physical Chemistry Specialization

Unit 01:

Skill to Read Research Articles:

A recent research article will be supplied and the students will have to answer some questions on the article.

[20]

Unit 02:

Research problem has to be finalized in consultation with the Incharge. The work has to be carried out under the supervision of the Incharge and Research Report of approximately 25 pages has to be submitted.

[60]

Unit 03

Seminar Lecture has to be delivered on the total work carried out. It will involve Power Point Presentation (Total number of slides = 10; total presentation time = 10 minutes (max.)).

[20]

CEM 495: Project (Organic Spl.) Full Marks = 100 Credits: 8 Duration: 16 Week

Review work / Industry Visit / Field work:

Review in an area of contemporary interest: Topic to be finalized in consultation with the Incharge and a Review-Report (approximately 10 pages) has to be submitted.

OR

Industry Visit: Dr. Dilip Rout (DR), Dr. Susovan Mandal (SM), Dr. Prasanta Patra (PP), Dr. Ansuman Bej (AB) & Dr. Tapas Kumar Adalder (TA): Organic Chemistry Specialization

It will involve visit to an **Industry** and submission of a Work-Report (approximately 10 pages) on the Industry Visit

OR

Field Work, Sample Collection and submission of a Work-Report (approximately 10 pages) on the Field Work. [30]

Research Work:

Research Work (extension from Semester III):

Unit 01:

Research problem has to be finalized in consultation with the Incharge. The work has to be carried out under the supervision of the Incharge and Research Report of approximately 25 pages has to be submitted.

[50]

Unit 02

Seminar Lecture has to be delivered on the total work carried out. It will involve Power Point Presentation (Industry visit: 2 slides, Review: 2 slides, Research work: 5 slides; total presentation time = 10 minutes (max.)).

[20]

Suggested Reading (Organic Chemistry):

1. Photochemistry and Pericyclic Reactions, Jagdamba Singh and Jaya Singh
2. Advanced Organic Chemistry, Part-A, F.A. Carey and R.J. Sundburg
3. Advanced Organic Chemistry, Part-B, F.A. Carey and R.J. Sundburg
4. March's Advanced Organic Chemistry, Michael B. Smith and Jerry March
5. Organic Chemistry, T.W. Graham, Solomons and Craig B. Fryhle
6. Organic Chemmistry, Paula Yurkanis Bruice
7. Green Chemistry, Paul T. Anantas and Tracy C. Williamson
8. Green Chemistry: Theory and Practice, Paul T. Anastas and John C. Warner
9. Molecular Gels: Materials with Self-Assembled Fibrillar Networks, Richard G. Weiss and P. Terech.
10. Spectroscopic Identification of Organic Compounds, Robert M. Silverstein and Francis X. Webster
11. Organic Synthesis: The Disconnection Approach, Stuart Warren
12. Modern Methods of Organic Synthesis: William Carruthers and Iain Coldham

Suggested Reading (Inorganic Chemistry):

1. Chemical Application of Group Theory – F.A. Cotton
2. Group Theory – Robert L. Carter
3. Symmetry in Chemistry – Jeffe & Archin
4. Symmetry in Molecules – J. M. Hollar
5. Symmetry Orbitals & Spectra – Jeffe & Archin
6. Physical Methods in Inorganic Chemistry – R. S. Drago
7. Electron Spin Resonance – Assculieien
8. Fundamentals of Molecular Spectroscopy – C. W. Banwell
9. Introduction to Molecular Spectroscopy – G. M. Barrow
10. Advanced Inorganic Chemistry – F. A. Cotton & G. Wilkinson
11. Inorganic Chemistry – J. E. HUheey, E. A. Keiter & R. L. Keiter
12. Chemistry of The Elements – N. N. Greenwood & A. Earnshaw
13. An Introduction to Inorganic Chemistry – K. F. Puecell & J. C. Kotz
14. Concept and Model in Inorganic Chemistry – Douglass, McDanniel & Alexander
15. Coordination Chemistry – S. F. A. Kettle
16. Valence Theoru – S. F. A. Kettle, J. N. Murral & S. Teddler

17. Valence – C. A. Coulson

18. Theoretical Approach to Inorganic Chemistry – A. F. Williams

19. Theoretical Inorganic Chemistry M. C. Dey and I. Selbin

20. Introduction to Ligand Field Theory – C. J. Ballhausen

21. Introduction to Ligand Field – B. N. Figgis

22. Inorganic Electronic Spectroscopy – A. B. P. Lever

23. Elements in Magnetochemistry – R. L. Dutta and A. Shyamal

24. Organo Transition Metal Chemistry – S. G. Davies

25. Principles and Application of Organotransition Metal Chemistry – J. P. Collman, L. S. Hegedus, Borton & R. G. Finke

26. Organometallic Chemistry – An Introduction – R. C. Mahrotra & A. Singh

27. Principles of Organometallic Chemistry _ G. E. Coats, H. L. H. Green, P.Powell & K. Wade

28. Basic Organomtallic Chemistry – J. J. Zuckerman and I. Haiduc

29. The Organometallic Chemistry of Transition Metals – R. H. Carbtree

30. Bioinorganic Chemistry – R. W. Hay

31. Introduction to Bioinorganic Chemistry - D.R. Williams

32. Elements of Bioinorganic Chemistry – G. N. Mukherjee & A. Das

33. Inorganic Chemistry – D. F. Shriver, P. W. Atkins & C. H. Langford

34. Instrumental Methods Analysis – Williiard, merit, Dean & Sett

35. Electroanalytical Techniques for Inorganic Chemistry – J. B. Headri

36. Comprehensive Coordination Chemistry – G. Wilkinson, R. A. Gillard & J. A. McCleverty (eds)

37. Inorganic Chemistry – A. G. Sharpe

38. Inorganic Chemistry – Modern Introduction

39. Fundamentals of Analytical Chemistry – D. A. Skoog, D. M. West and F. J. Holler

40. Analytical Chemistry – G. D. Christian

41. Analytical Chemistry, Principles – J. H. Kennedy

Practical (Inorganic) :

1. Spot Tests of Inorganic Analysis – F. Feigel & V. Anger (translated by R. Oesper)

2. Macro and Semi Macro Qualitative Inorganic Analysis - A. J. Vogel

3. Quantitative Inorganic Analysis - G. Charlot & D. Bezier (translated by R. C. Murray)

4. Quantitative Chemical Analysis - I. M. Kolthoff, E. B. Sandel, J. Meehan and S. Bruckenstei

5. Advanced Experiments in Inorganic Chemistry – G. N. Mukkherjee.

Suggested Reading (Physical Chemistry):

1. Elementary Quantum Chemistry – F. I. Pilar
2. Quantum Chemistry – I. N. Levine
3. Molecular Quantum Mechanics – P. W. Atkins
4. Quantum Mechanics – J. I. Powel, B. Crasemann
5. Introduction to Quantum Mechanics – D. J. Griffiths
6. The Feynman Lectures in Physics, Vol. 3 – R. P. Feynman, R. B. Leighton, M. Sands
7. Chemical Applications of Group Theory – F. A. Cotton
8. Group Theory and Chemistry – D. M. Bishop
9. Coulson‟s Valance - R. McWeeny
10. Thermodynamics and an Introduction to Thermodynamics – H. B. Callen
11. Theories of chemical reaction rates – K. J. Laider
12. Theory of Rate Processes – S. Glaasstone, K. J. Laidler, H. Eyring
13. Principles of Physical Biochemistry – K. E. van Holde, C. Johnson, P. S. Ho
14. Modern Electrochmistry – J. O‟M. Bockris, A. K. N. Reddy
15. Physical Chemistry of Macromolecules – C. Tanford
16. Polymer Chemistry – P. J. Flory
17. Molecular Spectroscopy – I. N. Levine
18. Molecular Spectroscopy – J. D. Graybeal
19. Principles of Fluorescence Spectroscopy – J. R. Lakowicz
20. Introduction to Magnetic Resonance – A. Carrington, A. D. McLachlan
21. Statistical and Thermal Physics – F. Reif
22. Statistical Mechanics – D. A. McQuarrie
23. Statistical Mechanics – S. K. Ma
24. Statistical Mechanics – K. Huang
25. Statistical Mechanics – R. K. Patharia
26. Statistical Mechanics – B. B. Laud
27. Chemical Kinetics and Dynamics – J. I. Steinfeld, J. S. Francisco, W. L. Hase
28. Molecular Reaction Dynamics – R. D. Levine
29. Molecular Reaction Dynamics and Chemical Reactivity – R. D. Levine, R. B. Bernstein
30. Introduction to Solid State Physics – C. Kittel
31. Introduction to Solid State Theory – O. Madelung
32. Solid State Physics – A. J. Dekker
33. Molecular Modelling Principles and Application – A. R. Leach
34. Genetic Algorithm in Search Optimization and Machine Learning-D.E. Goldberg
35. Computational Intelligence-A. Konar
36. Photodissociation Dynamics-R. Schinke

37. Modern Spectroscopy-J. M. Hollas
38. Symmetry and Spectroscopy-D. C. Harris, M. D. Bertolucci
39. Molecular Vibrations-E. B. Wilson Jr., J. C. Decius, P. C. Cross
40. Microwave Spectroscopy- C. H. Townes and A. L. Schawlow
41. Laser Spectroscopy- W. Demtroder
42. Practical Physical Chemistry- A. M. James, F. F. Prichard
43. Findlay‟s Practical Physical Chemistry- B. P. Levitt
44. Experimental Physical Chemistry- Shoemaker and Garland

Department of English
Jhargram Raj College
Syllabus Distribution
General- Even Semester
2021-22

Semester -II

DSC-1B(CC-2): Essay, Drama & Novel Credits 06
DSC1BT: Essay, Drama & Novel
Course Contents:
1. George Orwell – "Shooting an Elephant'
2. R. K. Narayan – "A Library without Books"
3. George Bernard Shaw – *Arms and the Man* SM
4. J. B. Priestley – *An Inspector Calls*
5. Ernest Hemingway – *The Old Man and the Sea* CD

Semester IV

DSC-1D (CC- 4): Academic Writing and Composition Credits 06
DSC1DT: Academic Writing and Composition
Course Contents:
1. Introduction to the Writing Process: Conventions of Academic Writing, Writing in one's own words – Summarizing and Paraphrasing DSM
2. Critical Thinking: Syntheses, Analyses, and Evaluation PMB
3. Structuring an Argument: Introduction, Interjection, and Conclusion PMB
4. Citing Resources, Editing, Book and Media Review :DSM

SEC-2: CreativeWriting Credits 02 DM
Course Contents:
Unit 1.
What is Creative Writing?
Unit 2.
The Art and Craft of Writing
Unit 3.
Modes of creative Writing

GE-4
GE4T: Environment & Literature SS
Course Contents:
Introduction (Nature in Oriental & Western Thought, Deep Ecology, Third World Environmentalism)
1. G M Hopkins. 'Binsey Poplars'
2. Mahasweta Devi. 'Pterodactyl'
3. Ruskin Bond. 'Dust on the Mountains'.

Semester -VI

DSE-2 : Nation, Culture and India Credits 06
DSE2T: Nation, Culture and India

Semester -VI

DSE-2 : Nation, Culture and India Credits 06
DSE2T: Nation, Culture and India
Semester -VI

DSE-2 : Nation, Culture and India Credits 06
DSE2T: Nation, Culture and India

Semester -VI

DSE-2 : Nation, Culture and India Credits 06
DSE2T: Nation, Cult

Course Contents:
1. AmartyaSen – "Secularism and its Discontents" (from *The Argumentative Indian*) 10
2. Rabindranath Tagore – "Nationalism and India" (from Nationalism) 15 (Teachers from Bengali Dept)

SEC-4: Business Communications Credits 02
Course Contents: CD
1. Introduction to the Essentials of Business Communication: Theory and Practice
2. Writing a project report
3. Citing References, using bibliographical and research tools
4. Writing minutes of meetings
5. E-Correspondence
6. Making oral presentations (Viva for internal assessment)
7. Spoken English for Business Communication (Viva for internal assessment)

Suggested Readings:
- Scot, O. Contemporary Business Communication. Biztantra, New Delhi.
- Lesikar, R. V. &Flatley, M. E. Basic Business Communication Skills for Empowering the Internet Generation, Tata McGraw Hill Publishing Company Ltd. New Delhi.

GE2T: Environment & Literature : SS
Course Contents:
Introduction (Nature in Oriental & Western Thought, Deep Ecology, Third World Environmentalism)

Course Contents:
1. AmartyaSen – "Secularism and its Discontents" (from *The Argumentative Indian*) 10
2. Rabindranath Tagore – "Nationalism and India" (from Nationalism) 15 (Teachers from Bengali Dept)

SEC-4: Business Communications Credits 02
Course Contents: CD
1. Introduction to the Essentials of Business Communication: Theory and Practice
2. Writing a project report
3. Citing References, using bibliographical and research tools
4. Writing minutes of meetings
5. E-Correspondence
6. Making oral presentations (Viva for internal assessment)
7. Spoken English for Business Communication (Viva for internal assessment)

Suggested Readings:
- Scot, O. Contemporary Business Communication. Biztantra, New Delhi.
- Lesikar, R. V. &Flatley, M. E. Basic Business Communication Skills for Empowering the Internet Generation, Tata McGraw Hill Publishing Company Ltd. New Delhi.

GE2T: Environment & Literature : SS
Course Contents:
Introduction (Nature in Oriental & Western Thought, Deep Ecology, Third World Environmentalism)

1. Gordon J. L. Ramel. ‘Daffodils No More’
2. Mahasweta Devi. ‘Pterodactyl’
3. Ruskin Bond. ‘Dust on the Mountains’,

Department of English
Jhargram Raj College
Syllabus Distribution
Honours- Even Semester
2021-22

Semester -II

CC3T: British Literature (fiction and non-fiction): 18th Century
Course Contents:
Play:

• William Congreve: *The Way of the World* :SS

Prose:
• Jonathan Swift:*Gulliver's Travels* (Books III and IV) :DM
• Addison and Steele: 'Sir Roger at Church' : CD
• Laurence Sterne: *The Life and Opinions of Tristram Shandy, Gentleman*

CC4T: British Romantic Literature (1798-1832)
Course Contents:

Poetry:
• William Blake: 'The Lamb', 'The Tyger' : DSM
• William Wordsworth: 'Tintern Abbey' : CD
• Samuel Taylor Coleridge: 'Christabel' Part-1 : SM
• Percy Bysshe Shelley: 'Ozymandias' : SS
• John Keats: 'Ode to a Nightingale' : PMB

Novel:
• Mary Shelley:*Frankenstein :* DSM
• Jane Austen: *Pride and Prejudice* : PMB

Semester IV

C8T: European Classical Literature

Course Contents:
• Homer: *The Iliad*, tr. E.V. Rieu (Harmondsworth: Penguin,1985)(Book I). : DM
• Sophocles: *Oedipus the King*, tr. Robert Fagles in *Sophocles: The Three Theban Plays* (Harmondsworth: Penguin, 1984). : PMB
• Plautus:*Pot of Gold*, tr. E.F. Watling (Harmondsworth: Penguin, 1965). : SS
• Ovid Selections from *Metamorphoses* 'Bacchus', (Book III), 'Pyramus and Thisbe' (Book IV), tr. Mary M. Innes (Harmondsworth: Penguin, 1975).

C9T: Modern European Drama

Course Contents:
• Henrik Ibsen: *Ghosts :* DSM
• Bertolt Brecht:*The Good Woman of Szechuan* : CD
• Samuel Beckett:*Waiting for Godot* : PMB

C10T: Popular Literature

Course Contents:
• Lewis Carroll: *Through the Looking Glass* : DSM
• Agatha Christie: *The Murder of Roger Ackroyd* : SM
• Shyam Selvadurai: *Funny Boy* : SS
• Sukumar Ray: *AbolTabol* (Translated by Sukanta Chowdhuri)/Autobiographical Notes on Ambedkar (For the Visually Challenged students) : CD

Semester VI

C13T: Indian Classical Literature

Course Contents:

• Kalidasa. *Abhijnana Shakuntalam,* tr. Chandra Rajan, in *Kalidasa: The Loom of Time* (New Delhi: Penguin, 1989). : PMB

• Vyasa. 'The Dicing' and 'The Sequel to Dicing, 'The Book of the Assembly Hall', 'The Temptation of Karna', Book V 'The Book of Effort', in *The Mahabharata:* tr. and ed. J.A.B. van Buitenen (Chicago: Brill, 1975) pp. 106–69. : PMB

• Sudraka. *Mrcchakatika,* tr. M.M. Ramachandra Kale (New Delhi: Motilal Banarasidass, 1962).:SS

C14T: Indian Writing in English

Course Contents: Poetry:
• R.K. Narayan: *Swami and Friends* : CD
• H.L.V. Derozio: 'The Harp of India'
• Kamala Das: 'Introduction' : CD
• Nissim Ezekiel: 'The Night of the Scorpion' : SM

Fiction:
• Mulk Raj Anand: 'Two Lady Rams' : DM
• Salman Rushdie: 'The Free Radio'

Drama:
• Girish Karnad: *Tughlaq :*SS

DSE3T: Science Fiction and Detective Literature

Course Contents:

• Wilkie Collins: *The Woman in White* : DSM
• Arthur Conan Doyle: *The Hound of the Baskervilles* : DSM

DSE4T: Partition Literature

Course Contents:

- Amitav Ghosh: *The Shadow Lines.*
- Dibyendu Palit: 'Alam's Own House', tr. Sarika Chaudhuri, *Bengal Partition Stories*: *An Unclosed Chapter*, ed. Bashabi Fraser (London: Anthem Press, 2008) pp. 453– 72. SM
- Manik Bandhopadhya, 'The Final Solution', tr. Rani Ray, *Mapmaking: Partition Stories from Two Bengals*, ed. Debjani Sengupta (New Delhi: Srishti, 2003) pp. 23–39. : SM

- Sa'adat Hasan Manto, 'Toba Tek Singh', in *Black Margins: Manto*, tr. M. Asaduddin (New Delhi: Katha, 2003) pp. 212–20.
- Jibananda Das, 'I Shall Return to This Bengal', tr. Sukanta Chaudhuri, in *Modern Indian Literature* (New Delhi: OUP, 2004) pp. 8–13. : DM

JHARGRAM RAJ COLLEGE
Department of History
Syllabus Distribution
Departmental Meeting: 27.09.2021.
B.A. General and Generic Elective
Semesters- 1, 3, 5
Session: 2021-22

Semester 1:-

- **DSC -1A-** **Ancient India:- (PURE PASS)**

Course Contents:-

1, 2 – CR

3, 4 - MM

5, 6- PD

SEMESTER 3:-

- **DSC -3A- Selected Themes in the Colonial Impact on Indian Economy and Society :- (PURE PASS)**

Course Contents:-

1- RP
2- RP
3- PD
4- CR
5- PD
6- CR

- **GE 3-Some Perspectives on Women's Rights in India:- (HONS PASS)**

Course Contents:-

1- CR
2- MM
3- MM
4- MM
5- CR
6- CR

- **<u>SEC- 1</u> – The Making of Indian Foreign Policy:-**

  (PURE PASS) <u>Course Contents:-</u>

  1- MM
  2- MM
  3- MM
  4- RP
  5- RP
  6- RP

SEMESTER-5 :-

- **DSE-1A- Renaissance and Reformation:- (PURE PASS)**

Course Contents:-

1. CR
2. MM
3. PD
4. PD

- **GE-1-Science and Empire:- (PURE PASS)**

Course Contents:-

1- RP
2- RP
3- SG
4- SG
5- SG

- **SEC-3-Colonial Science in India:- (PURE PASS)**

Course Contents:-

1- RP
2- RP
3- SG
4- SG
5- SG

JHARGRAM RAJ COLLEGE
Department of History
Syllabus Distribution [Departmental Meeting: 16.02.2022]
B.A. History General [Semesters: 2,4,6]
Academic Session: 2022

Courses	Teachers assigned
DSC-1B / 2B: Medieval India (Semester 2)	
1. Arab Conquest of Sindh: Nature and Impact.	**MM**
2. Causes and consequences of Early Turkish invasion.	**MM**
3. Mahmud of Ghazni and Shihab-ud-din of Ghur.	**MM**
4. Establishment and consolidation of the Sultanate: Qutb-ud-din Aibak to Firuz Shah Tughluqs, polity, economy, culture.	**PD**
5. Emergence of regional powers: Vijaynagar and Bahamani Kingdoms, Hussain Shahi and Illiyas Shahi Dynasties.	**PD**
6. Mughal Imperialism: Establishment and consolidation - Greater Mughals; polity, economy, culture.	**CR**
7. Socio-cultural syncretism, Bhakti & Sufi movements.	**CR**
DSC-1D / 2D: Modern Nationalism in India (Semester 4)	
Module 1: Nationalism in India and its historiography. Emergence of Nationalism in India, role of the new middle class, political associations before the foundation of INC, Safety Valve Theory, foundation of Indian National Congress, the moderates and economic nationalism.	**MM**
Module 2: The rise of Extremism and Swadeshi movement, anti-partition movement in 1905.	**CR**
Module 3: Gandhian Mass Movements—Non-cooperation, Civil Disobedience, Quit India Movement.	**PD**
Module 4: Roots of Communalism and Communal Award.	**PD**
Module 5: Demand for Pakistan: Pakistan Movement from Cripps Mission to Cabinet Mission Plan.	**PD**
Module 6: Partition and its Aftermath.	**CR**

SEC- 2: Literature and History: Bengal (Semester 4)	
1. History and Literature: An Overview	**PD**
2. Dichotomy between Itihasa and History- sense of itihasa in pre-colonial period as part of literature. Concept of 'mythic time' and 'historical time'. Beginning of history-writing in Bengal. Elements of literature in it.	**PD**
3. Novel as a new literary genre – looking at past through literature. Ramesh Chandra Majumdar, Akshay Kumar Maitreya, Raman Pillai, Chandu Menon, Phakirmohan Senapati.	**SG**
4. Power and Patriotism: Bankim's Nationalism: Bande Mataram, Anandamath Tagore's Nationalism and Universalism: His Novels: Ghare Baire and Char Adhyay.	**SG**
5. Sarat Chandra Chattopadhyay and the Indian Women of Early 20th Century: Some reflections in the novels - Charitrahin and Pother Dabi; Difference of Perspective between Bankim and Tagore.	**PD**
6. Narratives of Suffering - Economic and Caste discrimination: Tarashankar and the social milieu in the pre-Independent Bengal with special reference to Ganadevata and Hansuli Banker Upakatha.	**PD**
7. Satinath Bhaduri & the Gandhian Movement: Dhorai Charit Manas.	**SG**

DSE-1B / 2B: Post World War - II Politics (Semester 6)	
1. A New World Order and the Origin of the Cold War	**RP**
2. Cold War - Its Ideology and emergence of American and Soviet Block	**RP**
3. Economic and military alliance: NATO, SEATO, COMECON, Warsaw	**PD**
4. Crisis in Hungary, Polish question, Suez Crisis, Palestine problem, Iran Iraq conflict, Gulf War of 1990 - 91, Arab - Israel War	**PD**
5. Third World and Its ideology, organizations: OPEC, SAARC, ASEAN	**MM**
6. Détente	**RP**
7. Collapse of Soviet Bloc: Process of disintegration	**RP**

SEC-4: Art Appreciation: An introduction to Indian art (Semester 6)

I: Prehistoric and protohistoric art: Rock art; Harappan arts and crafts	**CR**
II: **Indian art (c. 600 BCE – 600 CE):** World Heritage Site Managers, UNESCO World Heritage Manuals [can be downloaded / accessed at www.unesco.org]	**SG**
Notions of art and craft - Canons of Indian paintings - Major developments in stupa, cave, and temple art and architecture	**CR**
Early Indian sculpture: style and iconography - Numismatic art	**SG**
III: Indian Art (c. 600 CE – 1200 CE): Temple forms and their architectural features - Early illustrated manuscripts and mural painting traditions Early medieval sculpture: style and iconography - Indian bronzes or metal icons	**SG**
IV: Indian art and architecture (c. 1200 CE – 1800 CE): Sultanate and Mughal architecture - Miniature painting traditions: Mughal, Rajasthani, Pahari; Introduction to fort, palace and haveli architecture	**SG**
V: Modern and Contemporary Indian art and Architecture: The Colonial Period Art movements: Bengal School of Art, Progressive Artists Group, etc. Major artists and their artworks - Popular art forms (folk art traditions)	**SG**

GE 2: Some Perspectives on Women's Rights in India (Semester 6)	
I. Definition of Human Rights • Human Rights and Women, a survey of the Charter • Interrogating Human Rights vis-à-vis personal laws in India • UN Convention and Indian context	**CR**
II. Indian Constitution and Women's Rights • Fundamental Rights and Women • Directive Principles and Women • Major legal cases defending women's rights vis-à-vis the constitution	**MM**
III. Preventive Acts • Minimum Wage Act 1948, Family Courts Act 1986, PNDT Act 1994, Latest Measures	**MM**
IV. Issues of Violence against Women and Remedial Measures • Domestic Violence Act, Prevention of Sexual Harassment at Workplace • Practical application and Problems, Remedial Measures	**MM**
V. Role of Non-Government Institutions • Non-Government Organizations and Human Rights • Women and Non-Government Organizations – Participations	**CR**

VI. Present Status • Issues of enabling and empowering modalities – Debate on uniform civil code	**CR**

JHARGRAM RAJ COLLEGE
Department of History
Syllabus Distribution [Departmental Meeting:27.09.2021]
B.A. Honours [Semesters: 1,3,5] Session: 2021-22

Courses	Teachers assigned
CC1 (Semester 1)	
Unit I	
Module I	RP
Module II	MM
Module III	MM
Module IV - 4.1	CR
Module IV - 4.2	PD
Module IV - 4.3	PD
Unit II	
Module I	RP
Module II	PD
Module III	OS
CC2 (Semester 1)	
Unit I	
Module I	RP
Module II	RP
Module III – 3.1	PD
Module III – 3.2	PD
Module III – 3.3	CR
Module III – 3.4	CR
Module IV	MM
Unit II	
Module I – 1.1	PD
Module I – 1.2	PD
Module I – 1.3	PD
Module I – 1.4	SG
Module I – 1.5	SG
Module II	SG
Module III	SG
Module IV	SG
CC5 (Semester 3)	
Module I	CR
Module II (a) [including Mameluks, Khaljis and Tughlaqs]	MM
Module II (a) [Theories of Kingship - ruling elites, ulema & political authority]	PD
Module II (b)	CR
Module II (c)	PD
Module III	MM
Module IV	MM
Module V (a)	CR
Module V (b)	CR
Module V (c)	SG

CC6 (Semester 3)	
Module 1	MM
Module 2	CR
Module 3	RP
Module 4	RP
Module 5	MM
CC7 (Semester 3)	
Module I	CR
Module I [18th century Debate]	SG
Module II	PD
Module III	PD
Module IV	RP
Module V	RP
Module VI	SG
Module VI [Sufism]	CR
SEC1 (Semester 3)	
Module I	CR
Module II [World Heritage Site Managers, UNESCO World Heritage Manuals]	SG
Module II [Notions of art and craft, canons of Indian paintings, major developments in stupa, cave, and temple art and architecture, early Indian sculptural styles]	CR
Module II [iconography and numismatic art]	SG
Module III	SG
Module IV	SG
Module V	SG
CC11 (Semester 5)	
Module 1	RP
Module 2	RP
Module 3	RP
Module 4	SG
Module 5	SG
Module 6	OS
CC12 (Semester 5)	
Module 1	SG
Module 2	CR
Module 3 [Ho, Tamar, Kol and Bhumij, Kherwar, Santal]	MM
Module 3 [Bhil, Kolis, Khasis, Koyas, Konds]	CR
Module 4	MM
Module 5	SG
Module 6	SG
DSE1 (Semester 5)	
Module 1	PD
Module 2	PD

Module 3	PD
Module 4	RP
Module 5	RP
DSE2 (Semester 5)	
Module 1	PD
Module 2	PD
Module 3	PD
Module 4	RP
Module 5	RP

JHARGRAM RAJ COLLEGE
Department of History
Syllabus Distribution [Departmental Meeting: 16.02.2022]
B.A. Honours [Semesters: 2,4,6]
Academic Session: 2022

Courses		Teachers assigned
CC-3: Mauryan and Gupta Empire (Semester 2)		
I.	Empire Building in India - Mahajanapadas to Kingdom	MM
II.	Formation of Mauryan Empire – Polity, Economy, Socio-Cultural Aspects, Downfall.	MM
III.	Post Mauryan Empire – Sungas & Kanvas, the Indo Greeks, Kushanas & Satavahanas.	RP
IV.	Imperial Guptas – Classical Age, Polity, Economy, Socio-Cultural Aspects, Downfall.	RP
CC-4: Political History of Early Medieval India, 600 AD to 1200 AD (Semester 2)		
Unit I		
Module I **Understanding the 'early medieval' phase in Indian history** 1.1 Different perceptions on the early medieval situations 1.2 Literary and archaeological sources 1.3 Development of regional cultures: an overview		PD
Module II **Shift of political power from Pataliputra to Kanauj** 2.1 Gauda under Sasanka: the most formidable power in eastern India 2.2 The Gauda-Kanyakubja struggle and the emergence of Harshavardhana 2.3 Military and political supremacy of Kanauj		PD
Module III **An overview of politics in the Deccan and south India** 3.1 The Chalukyas of Badami 3.2 Chalukya-Pallava struggle 3.3 Rashtrakuta- Pratihara rivalry 3.4 Rise of the Cholas as the premier power of the south		CR
Module IV Eastern India 4.1 The Palas and the tripartite struggle 4.2 Expansion of Pala power towards paramountcy 4.3 The Senas of Bengal		OS
Module V **The struggle for empire**		MM

5.1 The Ghaznavid raids 5.2 The Ghurids 5.3 Qutb-ud-din Aibak's conquests	
Unit II	
Module I **Political processes and structure of polity** 1.1 Absence of vast territorial empires -- a 'dark period'? 1.2 Emergence of feudal polity -- nature and structure of Indian feudalism 1.3 Zenith of political feudalism: 1000 - 1200 CE 1.4 The concept of segmentary state and the Indian experience	RP
Module II **The urban scenario** 2.1 Debates on the decay of urban centres 2.2 A third phase of urbanization?	RP
Module III **Administrative structures** 3.1 The Chola experiment -- a centralised state? 3.2 Land revenue system 3.3 Military organisation and administration of justice	CR
Module IV Towards transition 4.1 Conditions in India during the pre-Sultanate period 4.2 An overview of the cultural scenario	OS
CC-8: Renaissance and Reformation (Semester 4)	
Module 1: Political and social background – political system in early modern Europe – collapse of feudalism – and the changing economic life in the 15th and 16th century – commerce and navigation.	RP
Module 1: Monarchies and city states – features of the early modern state – the printing revolution.	PD
Module 2: Italian city states, the merchants, the church and the social context of the renaissance – origins of humanism – rediscovery of the classes – the impact of humanism on art, education and political thought.	OS
Module 2: Machiavelli and the idea of a modern state.	SG
Module 3: The background to the reformation – intellectual and popular anti-clericalism – Martin Luther and the reformation – reformation in the national context: France, Switzerland and England – the distinctiveness of the English reformation – Radical reformation – the Anabaptists, etc. - counter reformation.	SG
Module 4: Renaissance science and the emergence of a secular culture.	SG

CC-9: The French Revolution & Napoleon Bonaparte (Semester 4)	
Module I: Historiography of the French Revolution	SG
Module II: Crisis of the Ancien Regime	SG
Module III: Intellectual impetus	SG
Module IV: Socio-economic background	SG
Module V: Phases of the French Revolution – 1788-99	SG
Module VI: Rise of Napoleon – Empire building & consolidation	MM
Module VII: Impact of the French Revolution and Napoleon Bonaparte outside France	MM
Module VIII: Fall of Napoleon & Restoration of old order – Vienna Congress (1815) & Metternich	MM
CC-10: 19th Century Revolutions in Europe (Semester 4)	
Module I: The Greek War of Independence, the Revolutions of 1830, the Revolutions of 1848 – A possible turning point?	MM
Module II: The Age of Nationalism: The Second Empire in France and Louis Napoleon; Unification of Italy and Germany; The Third Republic and the Paris Commune	CR
Module III: Russia—Tsarist autocracy and reforms, the emergence of the revolutionary movement; the Eastern Question—the Crimean War, the Treaty of Paris, Balkan nationalism	PD
Module IV: Society and Economy in Nineteenth Century Europe: industrial transformation in Britain; difference in industrialization process between England and the Continental powers – France, Germany and Russia – the emergence of the working class and its movements – The impact of ideology: Louis Blanc	RP
Module V: Nationalism in Eastern and South Western Europe: Czech, Hungarian and Serbian	PD
SEC- 2: Colonial Science in India: Institutions and Practices (Semester 4)	
Module 1: Science in Colonial India: Problems and Perspectives	RP

Module 2: Science and Colonial Explorations: Science and Orientalism-Early European Scientists: Surveyors, Botanists, Doctors under the East India Company Service	RP
Module 3: Science in Practice: Botanical Garden, Geological Survey of India, Medical College, Indian Association for the Cultivation of Science	RP
Module 4: Science and Indigenous Personality: Prafulla Chandra Ray, Jagadish Bose, Mahendra Lal Sarkar, Maghnad Saha, C.V. Raman-Emergence of National Science	SG
Module 5: Colonial Science in India: Science and Indian Nationalism-Response and Resistance- Ideas of Mahatma Gandhi and other Indian Nationalists	SG

CC–13: International Relations after the Second World War (Semester 6)	
Module I: Nurnberg Trials, Germany 1945 – 46 Ruins of Europe and Japan; Charter of the United Nations at San Francisco Conference, 1945; Peace Settlement after the Second World War; Beginning of the Cold War: 1947	PD
Module II: Conflict between Superpowers USA and Soviet Union; Soviet Communism and the Russian leader Joseph Stalin; Soviet Union and Europe in Cold War 1945 – 1953; Military and Defence Alliances and Peace Pacts –Berlin after 1945- Fall of the Berlin Wall & German Re-Unification---- European Coal and Steel Community (ECSC); European Economic Community & European Atomic Energy Committee (Euratom)	OS
Module III: Decolonization and the emergence of the Third world National Movements in Asia & Africa---Third World Organizations-OPEC, ASEAN, SAARC	MM
Module III: Decolonization and the emergence of the Third world West Asian Crisis---, Palestine Problem; Suez Crisis, Iran- Iraq conflicts, Gulf War; Arab- Israel wars- activities of the PLO, Afghan Problem	PD
Module IV: Disintegration and Decline of the Soviet Union Glasnost and Perestroika – Crisis of Socialist regimes in other East European Countries: Poland, Germany, Czechoslovakia, Hungary – Response of the USA; Rise of a Unipolar World system, Globalization ---: Progress and development in science and technology--- Civil Rights Movement; Apartheid in South Africa—Terrorism	RP

CC-14: Modern Nationalism in India (Semester 6)	
Module 1: Nationalism in India and its historiography.	SG

Module 1: Emergence of Nationalism in India, role of the new middle class, political associations before the foundation of INC, Safety Valve Theory, foundation of Indian National Congress, the moderates and economic nationalism.	PD
Module 2: The rise of Extremism and Swadeshi movement, anti-partition movement in 1905.	CR
Module 3: Gandhian Mass Movements— Non-cooperation, Civil Disobedience, Quit India Movement.	SG
Module 4: Roots of Communalism and Communal Award.	SG
Module 5: Demand for Pakistan: Pakistan Movement from Cripps Mission to Cabinet Mission Plan.	SG
Module 6: Partition and its Aftermath.	SG

DSE-3: War and Diplomacy, 1914-1945 (Semester 6)

Unit I	
Module I: Through war to peace 1914 - 1920 1.1 The condition of Europe in 1914 1.2 The First World War: issues and stakes - appraisals and reappraisals 1.3 The dynamics of the war: Wilson's Fourteen Points	OS
1.4 The Versailles Settlement of 1919: context, provisions and evaluation 1.5 Other treaties	MM
1.6 Aftermath of the war	OS
Module II: Revolution and transformation in Russia 2.1 War- time politics in Russia 2.2 The provisional government under Kerensky 2.3 The Bolshevik Revolution: Lenin and Trotsky 2.4 The new Soviet Order 2.5 From Lenin to Stalin 2.6 Soviet foreign policy 1917-1939	SG
Module III: The inter-war period 3.1 The new balance of power 3.2 League of Nations 3.3 Draft Treaty of Mutual Assistance, 1923 3.4 Geneva Protocol, 1924 3.5 Locarno Treaties, 1925 3.6 Pact of Paris, 1928	MM
Unit II	
Module I: Road to another global war 1.1 Economic depression, 1929-32: prelude to the Second World War 1.2 Rise of dictatorship in Germany and Italy - a study in tyranny 1.3 Spain on fire: The Civil War, 1936-39	RP

1.4 Diplomatic moves: the Nazi-Soviet Nonaggression Pact and the Rome-Berlin-Tokyo Axis	
Module II: The gathering storm 2.1 A historiography of the Second World War 2.2 Hitler's foreign policy and origins of the war 2.3 With the Old Breed: from the Pacific Theatre to the Eastern and Western fronts 2.3 Reappraisal of the concept of appeasement	RP
Module III: Wartime politics in Europe 3.1 Coming of the Grand Alliance and conferences at Tehran, Yalta and Potsdam 3.2 The Lend-Lease policy of the United States 3.3 The allied victory and the collapse of wartime alliance	RP
DSE-4: Environmental History of India [Early India and Medieval Period] (Semester 6)	
Unit I a) Environmental history—Definition, Varieties and Sources b) India's Ecological Profile-Varied and Vast Landscape	SG
Unit II a) Social Uses of Natural Resources b) Resources- Renewable and Non-renewable Resources c) Mode of Resource Use in Gathering, Nomadic, Pastoralism, Agriculture and Industrial Mode	OS
Unit III a) Eclectic Belief Systems – Sacred Groves – Conservation from Above – Conservation from Below	SG
b) Indus Valley Civilization – Climatic factors for its rise and decline c) Agricultural Expansion and Deforestation in the Gangetic Valley d) Changing Perception of Forests in Early India	CR
Unit IV a) Expansions of Agrarian Frontiers, establishment of new settlements and trade networks in hilly, jungle and marshland regions during medieval period b) Changing Human Relations with animals-royal hunts c) Forest Dwellers and the pastoral communities in the medieval period	SG

Syllabus distribution of Physics (Hons & Gen) April 2021

1. Honours

Sem-II (H)		
Paper	**Topic**	**Teacher**
C-3	Electricity and Magnetism: **Electric Field and Electric Potential, Dielectric Properties of Matter, Magnetic Field, Magnetic Properties of Matter, Electromagnetic Induction**	SS
	Electricity and Magnetism: **Electrical Circuits,Networktheorems**	TG
C-4	Waves : **Superposition of Collinear Harmonic oscillations, Superposition of two perpendicular Harmonic Oscillations, Wave Motion, Velocity of Waves, Superposition of Two Harmonic Waves**	UD
	Optics: **Wave Optics, Interference, Diffraction and Holography**	SM
GE-2	Thermal Physics and Statistical Mechanics: **Laws of Thermodynamics, Thermodynamical Potentials**	SP
	Thermal Physics and Statistical Mechanics: **Kinetic Theory of Gases, Theory of Radiation, Statistical Mechanics**	TG
Sem-IV (H)		
Paper	**Topic**	**Teacher**
C-8	Mathematical Physics III: **Complex Analysis**	SS
	Mathematical Physics III: **Integrals Transforms**	SM
	Mathematical Physics III: **Matrices, Eigen-values and Eigenvectors**	SP
C-9	Elements of Modern Physics: **Unit 1, Unit 2**	SS
	Elements of Modern Physics: **Unit 3, Unit 4**	UD
C-10	**Analog Systems and Applications**	TG
GE-4	Electricity and Magnetism: **Vector Analysis, Electrostatics, Magnetism**	UD
	Electricity and Magnetism: **Electromagnetic Induction, Maxwell`s equations and Electromagnetic wave propagation**	SP
SEC-2	**Applied Optics**	SM
Sem-VI (H)		
Paper	**Topic**	**Teacher**
C-13	Electromagnetic Theory: **Maxwell Equations, EM Wave Propagation in Unbounded Media, EM Wave in Bounded Media**	SP
	Electromagnetic Theory: **Polarization of Electromagnetic Waves, Wave guides, Optical Fibres**	UD
C-14	Statistical Mechanics: Classical Statistical Mechanics, Bose-Einstein Statistics, Fermi-Dirac Statistics	SM
	Statistical Mechanics: **Classical Theory of Radiation, Quantum Theory of Radiation**	SS
DSE-3	**Communication Electronics**	TG
DSE-4	Experimental Techniques	SS+TG+UD +SP+ SM

2. General

Sem-II (G)		
Paper	**Topic**	**Teacher**
C-4: DSC-1B	Electricity and Magnetism : **Vector Analysis, Electrostatics, Magnetism**	SS
	Electricity and Magnetism : **Electromagnetic Induction, Maxwell`s equations and Electromagnetic wave propagation**	SP
Sem-IV (G)		
C-10: DSC 1D	Waves and Optics: **Superposition of Two Collinear Harmonic oscillations, Superposition of Two Perpendicular Harmonic Oscillations, Waves Motion- General, Fluids, Sound**	MA
	Waves and Optics: **Wave optics, Interference, Michelson's Interferometer, Diffraction, Polarization**	SM
SEC-2	Electrical Circuits and Network Skills: **Basic Electricity Principles, Understanding Electrical Circuits, Electrical Drawing and Symbols, Generators and Transformers**	MA
	Electrical Circuits and Network Skills: **Electric Motors, Solid-State Devices, Electrical Protection, Electrical Wiring**	TG
Sem-VI (G)		
DSE-2B	Solid State Physics: **Crystal Structure, Elementary Lattice Dynamics, Magnetic Properties of Matter, Dielectric Properties of Materials**	UD
	Solid State Physics: **Elementary band theory, Superconductivity**	SP
SEC-4	**Weather Forecasting**	MA

Syllabus distribution of Physics (Hons & Gen) April 2021

1. Honours

Sem-II (H)		
Paper	**Topic**	**Teacher**
C-3	Electricity and Magnetism: **Electric Field and Electric Potential, Dielectric Properties of Matter, Magnetic Field, Magnetic Properties of Matter, Electromagnetic Induction**	SS
	Electricity and Magnetism: **Electrical Circuits,Network theorems**	TG
C-4	Waves : **Superposition of Collinear Harmonic oscillations, Superposition of two perpendicular Harmonic Oscillations, Wave Motion, Velocity of Waves, Superposition of Two Harmonic Waves**	UD
	Optics: **Wave Optics, Interference, Diffraction and Holography**	SM
GE-2	Thermal Physics and Statistical Mechanics: **Laws of Thermodynamics, Thermodynamical Potentials**	SP
	Thermal Physics and Statistical Mechanics: **Kinetic Theory of Gases, Theory of Radiation, Statistical Mechanics**	TG
Sem-IV (H)		
Paper	**Topic**	**Teacher**
C-8	Mathematical Physics III: **Complex Analysis**	SS
	Mathematical Physics III: **Integrals Transforms**	SM
	Mathematical Physics III: **Matrices, Eigen-values and Eigenvectors**	SP
C-9	Elements of Modern Physics: **Unit 1, Unit 2**	SS
	Elements of Modern Physics: **Unit 3, Unit 4**	UD
C-10	**Analog Systems and Applications**	TG
GE-4	Electricity and Magnetism: **Vector Analysis, Electrostatics, Magnetism**	UD
	Electricity and Magnetism: **Electromagnetic Induction, Maxwell`s equations and Electromagnetic wave propagation**	SP
SEC-2	**Applied Optics**	SM
Sem-VI (H)		
Paper	**Topic**	**Teacher**
C-13	Electromagnetic Theory: **Maxwell Equations, EM Wave Propagation in Unbounded Media, EM Wave in Bounded Media**	SP
	Electromagnetic Theory: **Polarization of Electromagnetic Waves, Wave guides, Optical Fibres**	UD
C-14	Statistical Mechanics: Classical Statistical Mechanics, Bose-Einstein Statistics, Fermi-Dirac Statistics	SM
	Statistical Mechanics: **Classical Theory of Radiation, Quantum Theory of Radiation**	SS
DSE-3	**Communication Electronics**	TG
DSE-4	Experimental Techniques	SS+TG+UD +SP+ SM

2. General

Sem-II (G)		
Paper	**Topic**	**Teacher**
C-4: DSC-1B	Electricity and Magnetism : **Vector Analysis, Electrostatics, Magnetism**	SS
	Electricity and Magnetism : **Electromagnetic Induction, Maxwell`s equations and Electromagnetic wave propagation**	SP
Sem-IV (G)		
C-10: DSC 1D	Waves and Optics: **Superposition of Two Collinear Harmonic oscillations, Superposition of Two Perpendicular Harmonic Oscillations, Waves Motion- General, Fluids, Sound**	MA
	Waves and Optics: **Wave optics, Interference, Michelson's Interferometer, Diffraction, Polarization**	SM
SEC-2	Electrical Circuits and Network Skills: **Basic Electricity Principles, Understanding Electrical Circuits, Electrical Drawing and Symbols, Generators and Transformers**	MA
	Electrical Circuits and Network Skills: **Electric Motors, Solid-State Devices, Electrical Protection, Electrical Wiring**	TG
Sem-VI (G)		
DSE-2B	Solid State Physics: **Crystal Structure, Elementary Lattice Dynamics, Magnetic Properties of Matter, Dielectric Properties of Materials**	UD
	Solid State Physics: **Elementary band theory, Superconductivity**	SP
SEC-4	**Weather Forecasting**	MA

LESSON PLAN FOR THE SESSION 2021 - 2022

Name of Teacher: **Dr. Nivedita Bhattacharyya**

No. of Allotted Class/week: **25**

Duration	Paper Tought	NO. OF CLASS	DURATION (MINS)	TOPIC TAUGHT
14th September – 2nd Week of October	Paper C1T1	08	60	**Microscopy and Spectrophotometer**
	Paper C1P1	No allotted Classes		No allotted syllabus
	Paper C2T2	14	60	**Enzymes**
	Paper C2P2	20	60	**Biological Physics and Enzymes**
	Paper C5T	No allotted Classes		No allotted syllabus
	Paper C5P	20	60	**Hematological Experiments**
	Paper C6T	35	60	**Circulation except Special Circulation**
	Paper C6P	20		**Cardiovascular Physiology Experimental**
	Paper C7T	18	60	**Reflexes, Cutaneous Deep and Visceral Sensation**
	Paper C7P	24	60	**Neurological Experimental Practical**
	Paper SEC-1	08	60	**Clinical Biochemistry**
	Paper C11T	14	60	**Sensory Physiology: General Senses**
	Paper C11P	16	60	**Human Experiments**
	Paper C12T	10	60	**Endocrinology: General Consideration, Pituitary Gland, Thyroid Gland**
	Paper C12P	12	60	**Endocrinology Lab**
	Paper DSE 1T	No allotted Classes		No allotted syllabus
	Paper DSE 1P	No allotted Classes		No allotted syllabus
	Paper DSE 2T	18	60	**Pharmacology**
	Paper DSE 2P	20	60	**Pharmacology Practical**
2nd Week of November – 3rd Week of	Paper C1T1	12	60	**Microscopy and Spectrophotometer**
	Paper C1P1	No allotted Classes		No allotted syllabus
	Paper C2T2	10	60	**Enzymes**

December	Paper C2P2	14	60	**Biological Physics and Enzymes**
	Paper C5T	14	60	**Circulating Body Fluids**
	Paper C5P	14	60	**Hematological Experiments**
	Paper C6T	15	60	**Dynamics of Blood and Lymph Flow; Cardiovascular Regulatory Mechanisms**
	Paper C6P	No allotted Classes		No allotted syllabus
	Paper C7T	18	60	**Arousal Mechanism, Sleep & the Electrical Activity of the Brain; Control of Posture and Movement**
	Paper C7P	16	60	**Neurological Experimental Practical**
	Paper SEC-1	06	60	**Clinical Biochemistry**
	Paper C11T	10	60	**Vision**
	Paper C11P	12		**Human Experiments**
	Paper C12T	17	60	**Hormonal Control of Calcium Metabolism and Physiology of Bone; Endocrine Function of Pancreas and Regulation of Carbohydrate Metabolism**
	Paper C12P	20		**Endocrinology Lab**
	Paper DSE 1T	No allotted Classes		No allotted syllabus
	Paper DSE 1P	No allotted Classes		No allotted syllabus
	Paper DSE 2T	10		**Toxicology**
	Paper DSE 2P	12		**Toxicology Practical**
1st Week of January – 1st Week of June	Paper C3T	23	60	**Excitable Tissue : Nerve, Synaptic and Junctional Transmission**
	Paper C3P	24	60	**Histological Study, Experiment of Nerve and Muscle**
	Paper C4T	12	60	**Chemistry of Bio-molecules: Carbohydrate and Nucleic Acids**
	Paper C4P	08	60	**Biological Chemistry Lab**
	Paper C8T	30	60	**Energy Balance, Metabolism and Nutrition:** Introduction, Energy Metabolism, Carbohydrate Metabolism, Biological Oxidation, Protein, Fat and Cholesterol Metabolism
	Paper C8P	30	60	**Biochemical Estimation**
	Paper C9T	31	60	**Digestion and Absorption, Regulation of Gastrointestinal Function**
	Paper C9P	32	60	**Dale's Experiment**
	Paper C10T	18	60	**Regulation of Respiration**
	Paper C10P	No allotted Classes		No allotted syllabus
	Paper SEC-2T	16	60	**Public Health Assessment**
	Paper SEC-2P	20	60	**Experiment No. 1 to 8**

	Paper C13T	35	60	**Reproductive Physiology , Embryology and Chronobiology**
	Paper C13P	30	60	**Reproductive Physiology , Embryology and Chronobiology (Practical)**
	Paper C14T	No allotted Classes		No allotted syllabus
	Paper C14P	No allotted Classes		No allotted syllabus
	Paper DSE 3T	No allotted Classes		No allotted syllabus
	Paper DSE 3P	No allotted Classes		No allotted syllabus
	Paper DSE 4T	30	60	**Pathophysiological Basis of Disease**
	Paper DSE 4P	20	60	**Pathophysiological Basis of Disease (Practical)**

Head,
Department of Physiology
Jhargram Raj College

Name of Teacher: **Sri Sreejit Ghosh**

No. of Allotted Class/week: **27**

Duration	PAPER TAUGHT	NO. OF CLASS	DURATION PER CLASS (MINS)	TOPIC TAUGHT
3rd Week Of July – 3rd Week of September	Paper C1T1	14	60	**Structural units of human system**
	Paper C1P1	20	60	**Histology**
	Paper C2T2	08	60	**Instrumentation related to Biophysics**
	Paper C2P2	No allotted Classes		No allotted syllabus
	Paper C5T	35	60	**Circulating Body Fluids**
	Paper C5P	20	60	**Haematological Experiments**
	Paper C6T	No allotted Classes		No allotted syllabus
	Paper C6P	20	60	**Cardiovascular Physiology Experimental**
	Paper C7T	18	60	**The Autonomic Nervous System, Central Regulation of Visceral Function**
	Paper C7P	24	60	**Neurological Experimental Practical**
	Paper SEC1T	08	60	**Clinical Biochemistry**
	Paper C11T	10	60	**Hearing and Equilibrium**
	Paper C11P	10	60	**Histological Experiments**
	Paper C12T	14	60	**Endocrinology: Mode of Steroid Hormone Action, Adrenal cortex and Adrenal Medulla**
	Paper C12P	16	60	**Endocrinology Lab**
	Paper DSE 1T	14	60	**Bio Statistics**
	Paper DSE 1P	16	60	**Bio Statistics Practicals**
	Paper DSE 2T	No allotted Classes		No allotted syllabus
	Paper DSE 2P	No allotted		No allotted syllabus

		Classes		
1st Week of November – 3rd Week of December	Paper C1T1	12	60	**Structural units of human system**
	Paper C1P1	14	60	**Histology**
	Paper C2T2	10	60	**Instrumentation related to Biophysics**:
	Paper C2P2	No allotted Classes		No allotted syllabus
	Paper C5T	14	60	**Circulating Body Fluids**
	Paper C5P	14	60	**Haematological Experiments**
	Paper C6T	No allotted Classes		No allotted syllabus
	Paper C6P	10	60	**Cardiovascular Physiology Experimental**
	Paper C7T	18	60	**Neural Basis of Instinctual Behavior and Emotion, Higher Function of the Nervous System**
	Paper C7P	16	60	**Neurological Experimental Practical**
	Paper SEC1T	06	60	**Clinical Biochemistry**
	Paper C11T	12	60	**Smell and Taste**
	Paper C11P	12	60	**Histological Experiments**
	Paper C12T	13	60	**Endocrine Functions of Kidneys, Heart and Pineal Gland**
	Paper C12P	18	60	**Endocrinology Lab**
	Paper DSE 1T	12	60	**Biostatistics**
	Paper DSE 1P	16	60	**Biostatistics**
	Paper DSE 1T	No allotted Classes		No allotted syllabus
	Paper DSE 1P	No allotted Classes		No allotted syllabus
1st Week of January – 1st Week of June	Paper C3T	23	60	**Excitable Tissue : Muscle, Initiation of Impulse in Sense Organs**
	Paper C3P	24	60	**Histological Study, Experiment of Nerve and Muscle**
	Paper C4T	08	60	**Chemistry of Biomolecules: Protein and lipid**
	Paper C4P	12	60	**Biological Chemistry Lab**
	Paper C8T	30	60	**Energy Balance, Metabolism and Nutrition:** Reactive Oxygen Species and Nutrition
	Paper C8P	No allotted Classes	60	No allotted syllabus
	Paper C9T	No allotted Classes		No allotted syllabus
	Paper C9P	16	60	**Dale's Experiment**

	Paper C10T	18	60	**Pulmonary Function, Gas Transport and Respiratory Adjustments**
	Paper C10P	16	60	**Respiratory Human Experiments**
	Paper SEC-2T	16	60	**Physiological Techniques**
	Paper SEC-2P	20	60	**Experiment No. 9 to15**
	Paper C13T	No allotted Classes		No allotted syllabus
	Paper C13P	No allotted Classes		No allotted syllabus
	Paper C14T	35	60	**Renal Physiology, Skin & Body Temperature Regulation, Biomedical Instrumentation**
	Paper C14P	30	60	**Renal Physiology, Skin & Body Temperature Regulation, Biomedical Instrumentation (Practical)**
	Paper DSE 3T	30	60	**Medical Microbiology and Immunology**
	Paper DSE 3P	20	60	**Medical Microbiology and Immunology (Practical)**
	Paper DSE 4T	No allotted Classes		No allotted syllabus
	Paper DSE 4P	No allotted Classes		No allotted syllabus

Dr. Nivedita Bhattacharyya
Head,
Department of Physiology
Jhargram Raj College

SYLLABUS DISTRIBUTION

POLITICAL SCIENCE

ACADEMIC SESSION-2021-2022

SEMESTER -I (HONS)

Sl No.	Name of the Teacher	Course Code	Course Module
01	Ramchandra Pramanik	CC - 1	Unit – I , Module – 1,2
02	Sikander Ansari	CC - 1	Unit – I , Module – 3,4
03	Sridam Ghosh	CC - 1	Unit – II , Module – 1,2
04	Pravanjan Jana	CC - 1	Unit – II , Module – 3,4
05	Bhabesh Mahata	CC - 2	Unit – I , Module – 1(a)
06	Ranjit Kr. Kapat	CC - 2	Unit – I , Module – 1(b)
07	Ajoy Gopal Bera	CC - 2	Unit – II, Module – (a),(b),(c)
08	Biswajit Dutta	CC - 2	Unit – III, Module – (a),(b)

Generic Elective (GE) (Nationalism in India)

Sl No	Name of the Teacher	Course Code	Course Module
01	Ramchandra Pramanik	GE - 1	Unit – I, Module – 1
02	Sikander Ansari	GE - 1	Unit – II, Module – 1
03	Sridam Ghosh	GE - 1	Unit – III, Module – (a),(b)
04	Pravanjan Jana	GE - 1	Unit – III, Module – (c)
05	Bhabesh Mahata	GE - 1	Unit – IV, Module – (a)
06	Ranjit Kr. Kapat	GE - 1	Unit – IV, Module – (b)
07	Ajoy Gopal Bera	GE - 1	Unit – IV, Module – (c)
08	Biswajit Dutta	GE - 1	Unit – V, Module – (a),(b)

SEMESTER -I (General)

Sl No	Name of the Teacher	Course Code	Course Module
01	Ramchandra Pramanik	DSC – 1A	Unit – I , Module – (a)
02	Sikander Ansari	DSC – 1A	Unit – I, Module – (b)
03	Sridam Ghosh	DSC – 1A	Unit – II, Module – (a)
04	Pravanjan Jana	DSC – 1A	Unit – II, Module – (b)
05	Bhabesh Mahata	DSC – 1A	Unit – III, Module – (a)
06	Ranjit Kr. Kapat	DSC – 1A	Unit – III, Module – (b)
07	Ajoy Gopal Bera	DSC – 1A	Unit – III, Module – (c)
08	Biswajit Dutta	DSC – 1A	Unit – III, Module – (d)

SYLLABUS DISTRIBUTION

POLITICAL SCIENCE

ACADEMIC SESSION-2021-2022

SEMESTER -II (HONS)

Sl No	Name of the Teacher	Course Code	Course Module
01	Ramchandra Pramanik	CC - 3	Section – A , Unit – I , Module – (a) , (b)
02	Sikander Ansari	CC - 3	Section – A, Unit – II, Module – (a), (b) , (C)
03	Sridam Ghosh	CC - 3	Section – A , Unit – III , Module – (a) , (b) , (C)
04	Pravanjan Jana	CC - 3	Section – A, Unit – IV, Module – (a), (b), (C), (d)
05	Bhabesh Mahata	CC - 3	Section – B , Unit – I , Module – (a) , (b) , (C)
06	Ranjit Kr. Kapat	CC - 4	Module – I, II
07	Ajoy Gopal Bera	CC - 4	Module – III, IV
08	Biswajit Dutta	CC - 4	Module – V , VI , VII

Generic Elective (GE)

Governance: issues and challenges

Sl No	Name of the Teacher	Course Code	Course Module
01	Ramchandra Pramanik	GE - 2	Unit – I , Module – (a)
02	Sikander Ansari	GE - 2	Unit – I , Module – (b)
03	Sridam Ghosh	GE - 2	Unit – II ,Module – (a)
04	Pravanjan Jana	GE - 2	Unit – III ,Module – (a)
05	Bhabesh Mahata	GE - 2	Unit – III ,Module – (b)
06	Ranjit Kr. Kapat	GE - 2	Unit – IV ,Module – (a) , (b)
07	Ajoy Gopal Bera	GE - 2	Unit – V ,Module – (a) , (b)
08	Biswajit Dutta	GE - 2	Unit – V ,Module – (c) , (d)

SEMESTER -II (General)

Sl No	Name of the Teacher	Course Code	Course Module
01	Ramchandra Pramanik	DSC – 1B	Unit – 1
02	Sikander Ansari	DSC – 1B	Unit – 2
03	Sridam Ghosh	DSC – 1B	Unit - 3
04	Pravanjan Jana	DSC – 1B	Unit - 4
05	Bhabesh Mahata	DSC – 1B	Unit - 5
06	Ranjit Kr. Kapat	DSC – 1B	Unit - 6
07	Ajoy Gopal Bera	DSC – 1B	Unit - 7
08	Biswajit Dutta	DSC – 1B	Unit - 8

SEMESTER – III (Hons)

Sl No	Name of the Teacher	Course Code	Course Module
01	Ramchandra Pramanik	Cc – 5, SEC- 1	Section-1, a,b, SEC-1 unit-1
02	Sikandar Ansari	CC – 5, SEC- 1	Section- 2, a, b, c. SEC- Unit-2 a, b, c
03	Sridam Ghosh	CC- 5, SEC-1	Section-3, SEC – Unit – 2, d, e,f,g
04	Pravanjan Jana	CC- 6, SEC - 1	Section – 1, SEC- Unit- 2, h, I, j
05	Bhabesh Mahata	CC- 6, SEC - 1	Section – 2, SEC – Unit – 2, k, l.
06	Ranjit Kr. Kapat	CC – 6, SEC - 1	Section – 3,4. Sec – Unit – 3, a, b.
07	Ajoy Gopal Bera	CC – 7	Section – A, B
08	Biswajit Dutta	CC - 7	Section - C

Generic Elective (GE)

Gandhi and the contemporary world (GE- 3)

Sl No	Name of the Teacher	Course Code	Course Module
01	Ramchandra Pramanik	GE- 3	Unit – 1, A, B
02	Sikandar Ansari	GE - 3	Unit – 2, A
03	Sridam Ghosh	GE – 3	Unit – 2, B
04	Pravanjan Jana	GE – 3	Unit – 3, A, B.
05	Bhabesh Mahata	GE – 3	Unit – 3, C.
06	Ranjit Kr. Kapat	GE - 3	Unit – 3, D
07	Ajoy Gopal Bera	GE – 3	Unit – 4, A
08	Biswajit Dutta	GE - 3	Unit – 4 B

SEMESTER -III (General)

Comparative Government and Politics

Sl No	Name of the Teacher	Course Code	Course Module
01	Ramchandra Pramanik	DSC - 1C (CC-3) , SEC - 1	Unit – 1 , SEC - 1 - 1, 2
02	Sikandar Ansari	DSC - 1C (CC-3) , SEC - 1	Unit – 2 , SEC - 1 - 3 , 4, 5
03	Sridam Ghosh	DSC - 1C (CC-3)	Unit – 3 - (a)
04	Pravanjan Jana	DSC - 1C (CC-3)	Unit – 3 - (b)
05	Bhabesh Mahata	DSC - 1C (CC-3)	Unit – 4
06	Ranjit Kr. Kapat	DSC - 1C (CC-3)	Unit – 5
07	Ajoy Gopal Bera	DSC - 1C (CC-3)	Unit – 6 - (partly)
08	Biswajit Dutta	DSC - 1C (CC-3)	Unit – 6 - (partly)

SEMESTER – IV (Hons)

Sl No	Name of the Teacher	Course Code	Course Module
01	Ramchandra Pramanik	CC – 8, SEC - 2	Section – 1,2. SEC – 2, Unit - 1
02	Sikandar Ansari	CC – 8, SEC - 2	Section – 3,4. SEC – 2, Unit - 2
03	Sridam Ghosh	CC – 8, SEC - 2	Section – 5, 6. SEC – 2, Unit - 3
04	Pravanjan Jana	CC – 9, SEC - 2	Section – 1, 2. SEC – 2, Unit - 4
05	Bhabesh Mahata	CC – 9, SEC - 2	Section – 3, 4. SEC – 2, Unit - 5
06	Ranjit Kapat	CC – 9	Section - 5
07	Ajoy Gopal Bera	CC - 10	Section - 1
08	Biswajit Dutta	CC - 10	Section – 2, 3.

Generic Elective – (GE)

United Nations and Global Conflicts (GE – 4)

Sl No	Name of the Teacher	Course Code	Course Module
01	Ramchandra Pramanik	GE – 4	Unit – 1, A, B
02	Sikandar Ansari	GE – 4	Unit – 1, C
03	Sridam Ghosh	GE – 4	Unit – 1, C
04	Pravanjan Jana	GE - 4	Unit – 1, D
05	Bhabesh Mahata	GE – 4	Unit – 1, E
06	Ranjit Kapat	GE – 4	Unit – 2, A, B
07	Ajoy Gopal Bera	GE – 4	Unit – 2, C
08	Biswajit Dutta	GE - 4	Unit – 2, D

SEMESTER -IV (General)

Introduction to International Relations

Sl No	Name of the Teacher	Course Code	Course Module
01	Ramchandra Pramanik	DSC - 1D (CC -4) , SEC - 2	Unit – 1, a,b ,SEC - 2 - I ,II ,III
02	Sikandar Ansari	DSC - 1D (CC -4) , SEC - 2	Unit – 1, c,d , SEC - 2 - IV , V .
03	Sridam Ghosh	DSC - 1D (CC -4)	Unit – 2, a
04	Pravanjan Jana	DSC - 1D (CC -4)	Unit – 2, b
05	Bhabesh Mahata	DSC - 1D (CC -4)	Unit – 2, c
06	Ranjit Kapat	DSC - 1D (CC -4)	Unit – 3, a
07	Ajoy Gopal Bera	DSC - 1D (CC -4)	Unit – 3, b
08	Biswajit Dutta	DSC - 1D (CC -4)	Unit – 3, c

SEMESTER – V (Hons)

Sl No	Name of the Teacher	Course Code	Course Module
01	Ramchandra Pramanik	CC - 11	Section – I, II
02	Sikandar Ansari	CC - 11	Section – III, IV
03	Sridam Ghosh	CC - 12	Section – I, II, III, IV
04	Pravanjan Jana	CC - 12	Section – V, VI, VII, VIII
05	Bhabesh Mahata	DSE - 1	Section – I, II, III
06	Ranjit Kapat	DSE - 1	Section – IV, V, VI
07	Ajoy Gopal Bera	DSE - 2 (or) United Nations	Section – I, III,
08	Biswajit Dutta	DSE - 2 (or) United Nations	Section – II

SEMESTER -V (General) DSE - 1 A

Themes in Comparative Political Theory

Sl No	Name of the Teacher	Course Code	Course Module
01	Ramchandra Pramanik	DSC - 1 A, SEC - 3	Unit – 1, SEC - 3 - Unit – 1
02	Sikandar Ansari	DSC - 1 A, SEC - 3	Unit – 2, a, b, SEC - 3 -Unit – 2 (Partly)
03	Sridam Ghosh	DSC - 1 A, SEC - 3	Unit – 2, c, d, SEC - 3 -Unit – 2 (Partly)
04	Pravanjan Jana	DSC - 1 A, SEC - 3	Unit – 2, e, SEC - 3 - Unit – 2 (Partly)
05	Bhabesh Mahata	DSC - 1 A, SEC - 3	Unit – 3 , a , SEC - 3 - Unit – 2 (Partly)
06	Ranjit Kapat	DSC - 1 A, SEC - 3	Unit – 3, b , SEC - 3 - Unit – 2 (Partly)
07	Ajoy Gopal Bera	DSC - 1 A, SEC - 3	Unit – 3, c, SEC - 3 - Unit – 3 (Partly)
08	Biswajit Dutta	DSC - 1 A, SEC - 3	Unit – 3, d, e, SEC - 3 - Unit – 3 (Partly)

Semester - v (General)

Generic Elective -1 (Nationalism in India)

Sl No	Name of the Teacher	Course Code	Course Module
01	Ramchandra Pramanik	GE - 1	Unit – I , Module – 1
02	Sikander Ansari	GE - 1	Unit – II, Module – 1
03	Sridam Ghosh	GE - 1	Unit – III, Module – (a),(b)
04	Pravanjan Jana	GE - 1	Unit – III, Module – (c)
05	Bhabesh Mahata	GE - 1	Unit – IV, Module – (a)
06	Ranjit Kr. Kapat	GE - 1	Unit – IV, Module – (b)
07	Ajoy Gopal Bera	GE - 1	Unit – IV, Module – (c)
08	Biswajit Dutta	GE - 1	Unit – V, Module – (a),(b)

SEMESTER – VI (Hons)

Sl No	Name of the Teacher	Course Code	Course Module
01	Ramchandra Pramanik	CC - 13	Section – I, II
02	Sikandar Ansari	CC - 13	Section – III, IV
03	Sridam Ghosh	CC - 14	Section – I, II, III, IV, V
04	Pravanjan Jana	CC - 14	Section – VI, VII, VIII, IX, X, XI
05	Bhabesh Mahata	DSE - 3 or Women, Power and Politics	Section – I- 1, 2, 3
06	Ranjit Kapat	DSE - 3 or Women, Power and Politics	Section – II - 1, 2, 3
07	Ajoy Gopal Bera	DSE - 4	Section – I - a, b, c
08	Biswajit Dutta	DSE - 4	Section – II - a, b, c and III - a, b, c

SEMESTER – VI (General)Generic Elective – 2 OR

United Nations and Global Conflicts (GE – 2)

Sl No	Name of the Teacher	Course Code	Course Module
01	Ramchandra Pramanik	GE – 4	Unit – 1, A, B
02	Sikandar Ansari	GE – 4	Unit – 1, C
03	Sridam Ghosh	GE – 4	Unit – 1, C
04	Pravanjan Jana	GE - 4	Unit – 1, D
05	Bhabesh Mahata	GE – 4	Unit – 1, E
06	Ranjit Kapat	GE – 4	Unit – 2, A, B
07	Ajoy Gopal Bera	GE – 4	Unit – 2, C
08	Biswajit Dutta	GE - 4	Unit – 2, D

SEMESTER – VI (General) DSE – 1B

Administration and Public Policy: Concepts and Theories

Sl No	Name of the Teacher	Course Code	Course Module
01	Ramchandra Pramanik	DSE – 1 B	Unit – 1 (a)
02	Sikandar Ansari	DSE – 1 B	Unit – 1 (b)
03	Sridam Ghosh	DSE – 1 B	Unit – 2 (a)
04	Pravanjan Jana	DSE – 1 B	Unit – 2 (b)
05	Bhabesh Mahata	DSE – 1 B	Unit – 3 (a)
06	Ranjit Kapat	DSE – 1 B	Unit – 3 (b)
07	Ajoy Gopal Bera	DSE – 1 B	Unit – 4 (a)
08	Biswajit Dutta	DSE – 1 B	Unit – 4 (b)

SEMESTER – VI (General) SEC - 4

Conflict and Peace Building

Sl No	Name of the Teacher	Course Code	Course Module
01	Ramchandra Pramanik	SEC - 4	Unit – I (a, b)
02	Sikandar Ansari	SEC – 4	Unit – i (c)
03	Sridam Ghosh	SEC – 4	Unit – ii (a, b)
04	Pravanjan Jana	SEC – 4	Unit – ii (c)
05	Bhabesh Mahata	SEC – 4	Unit – iii (a, b)
06	Ranjit Kapat	SEC – 4	Unit – iii (c)
07	Ajoy Gopal Bera	SEC – 4	Unit – iv (a, b)
08	Biswajit Dutta	SEC - 4	Unit – iv (c, d)

JHARGARM RAJ COLLEGE

DEPARTMENT OF SANSKRIT

SYLLABUS DIVISION OF SEMESTER II

(CC, GE, DSC)

W.E.F. -

	SC	SB	DD	DM
CC3	**Vedic Lit., Puranas , Ind. Poetics**	**Mahabharata, Hist. of Grammar**	**Vedic Lit., Brh,Ark,Upa,Vedg Hist. of Ind. Philosophy**	**Ramayana**
CC4	********	**Gita-Conflict Resolution, Gita- Surrender of Ego**	**Gita- Cog.& Emo. Ap Gita- Contr. of Mind**	**Gita- Self Management**
GE2	**Morphology, Source of Enrichment of Sanskrit**	**Syntax of Sanskrit**	**Stages of I.A.**	**Phonetics of Sans. Lang. Sanskrit as a Source**
DSC2	**Sec.- C,Ut.I,**	**Sec.- A,Ut.I,II,**	**Sec.- B,Ut.I,II,**	**Sec.- C,Ut.II,**

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DEPARTMENT OF SANSKRIT

SYLLABUS DIVISION OF SEMESTER III

(CC, GE, DSC)

W.E.F. – 29.07.2019

	SC	SB	DD	DM
CC5	**Mudraraksasam Act –I,II,III**	**Abh.Sakuntala Act- I ,IV**	**Survey Sans. Drama**	**Vasavadatta Act – I, VI**
CC6	**Forms of Kavya Lit.**	**Sans. Poetics**	**Sabdasakti & Rasasutra**	**Alamkara & Chanda**
CC7	**Indian Social institution : Nature & Concept** **Cardinal Theories & Thinkers of Indian Polity**	**Indian Polity : Origin & Development**	**Structure of Society & Value of Life**	********
SEC3	**Abhinaya**	**Assignment of Role** **Types of Dramatic Production**	**Definition of Abhinaya & its Types** **Dialogue Writing**	**Division of Plot**
GE 3	**Mimamsa** **Bhakti Schools of Vedanta** **Six Pramanas**	**Carvaka , Jaina, Bouddha** **Nyaya** **Ethics**	**Samkhya & Yoga** **Advaita Vedanta** **Metaphysics**	**Fundamentals of Indian Philosophy**
DSC3	**Pratimanatak Act- I &III**	**Abh.Sakuntala Act- IV**	**Technical Terms** **Dramaturgy**	**Hist. of Sans. Drama**
SEC3	**********	**Unicode & Digitization of Skt. Text**	**Basic Computer Awareness**	********

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DEPARTMENT OF SANSKRIT

SYLLABUS DIVISION OF SEMESTER I

(CC, GE, DSC)

W.E.F. -27.07.2019

	SC	SB	DD	DM
CC1	**Nitisatak** **Vrs. 1-20**	**Mahakavya & Gitikavya** **Kumarsamvaba** **C-V, Vrs . 1-30**	**Raghuvamsa** **C-I , Vrs. 1-25**	**Kirat.** **C-I, Vrs. 1-25**
CC2	**Visrutacarit** **Upto 15th Para**	**Sukonasopadesa**	**Hist. of Prose Romance & Fable Lit.**	
GE1	**bhavat,gunin,atman, vak,jagat** **satri,sanac, kavatu , kta, ktva, lyap, tumun** **Active –passive**	**a and i ending feminine words, yat ,kim,** **root- jna, sev , labh,da**	**i and u ending masculine words , visarga & vowel sandhi** **Gita. Chp.XII**	**asmad,yusmad, etat,tat, path,khad, likh**
DSC1	**Sisupalavadh** **C-II, Vrs. 26-37**	**Nitisatak** **Vrs. 1-20**	**Raghuvamsa** **C-I , Vrs. 1-25**	**Hist. of Sans. Poetry**

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DEPARTMENT OF SANSKRIT

SYLLABUS DIVISION OF SEMESTER IV

(CC, SEC,GE, DSC)

W.E.F. -

	SC	SB	DD	DM
CC8	**SA, U-1, Intro Epigr. SB,U1, Writing SC,U1, Girnar, Sarna SD,U1, Chronology**	**SA,U-4,Decipher. SB,U3,Scripts SC,U4, Topra SD,U3, Era**	**SA,U2,Imp.Inscrip SB,U2, Wrt. Mater SC,U3, Samudra SD,U2, Chronogra**	**SA,U3, Epigr. SA,U3, Rudrada.**
CC9	**SA,U1, Bhimayanam SC,U1, Bacchulal.. SD,U2, Janaki Vallav.**	**SA,U1, Svatantra. SC,U3, Haiku… SD,U3, Haridas …**	**SB,U2, Sardula SC,U2, Hariram… SD,U1, Kshama**	**SB,U1, Sataparvika**
CC10	**SC,U1,2 Sans. Fable**	**SE,U1,KalidasaWest SF,U1, Sans. Across World**	**SB,U1,2, Upanisad & Gita SD,U1,2 Rama.., Maha..**	**SA,U1,2,3 Survey Sans. Lit.**
SEC2	**********	**SA, U1, Wrt. In India**	**SB,U1, Brahmi…**	**********
GE4	**SB,U1,2 Concept of Rastra**	**SC,U1,2 Nationalism Rise & Modern Lit.**	**SA,U1,2, Nationalism Concept &Nature**	
DSC1D	**SA,U1, Laghu.- Samjna,**	**Vibhakti**		**SB,U2, Laghu.- Sandhi**
SEC2	**SC,U1, Yoga- Vibhuti**	**SB,U1,2 Sadhan**	**SA,U1,2 Yoga- Samadhi,**	

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DEPARTMENT OF SANSKRIT

SYLLABUS DIVISION OF SEMESTER V
(Hons.-CC, DSE)
W.E.F.

	SC	SB	DD	DM
CC11	**S-A,U-2, Yajurveda Siva. Snk. S-B, U-1, Ved.Grm.**	**S-A,U-1, Rg.Veda Agni Skt. U-3, Arth.Veda Bhumi Skt. S-B, U-3, Mund.2.2-2.3**	**S-A,U-3, Arth.Veda Sammanasyam S-B, U-3, Mund.1.1-2.1**	**S-A,U-1,Rg.Veda Usas, Aksa, Hiranya,**
CC12	**S-A, U-1, Laghu. Samja**	**S-B,U-1, Vibkt.**	**S-B,U-1,2,3 Sandhi**	**********
DSE1B	**S-C, U-1, Ref. Bev.**	**S-A,U-1, Self.Pres.**	**S-B,U-1, Concen.**	**S-B,U-1, Eight Yoga**
DSE2A	**S-B,U-1, Drama**	**S-A,U-1, Theatre**	**S-B,U-3, Rasa S-B, U-1, Tra. & Hist. Ind. The.**	**S-B,U-2, Neta**

Sem-V_DSC (DSE, SEC,GE)

	SC	SB	DD	DM
DSE-1A-Philo,Reli,Cul.	**S-A,U-III, Lila, Kripa**	**S-B, U-I,II Samskara, Purusartha**	**S-C,U-I, Swadharma**	**S-A, U-I, Bhakta**
SEC-3 Tools & Tech.	**S-A, U-1, S-B, U-2**	**S-C, U-1&2**	**S-A, U-2, S-B, U-1**	**S-A, U-3**
GE-1T Pol. Thought In Sanskrit	**S-B, U-1 S-C, U-1**	**S-A, U-1**	**S-C, U-2**	**S-A, U-2 S-B, U-2**

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DEPARTMENT OF SANSKRIT

SYLLABUS DIVISION OF SEMESTER VI
(Hons.-CC, DSE)
W.E.F.

	SC	SB	DD	DM
CC13	**S-B, U-1, 2,3&4**	**S-C, U-1,2 & 3**	**S-A, U-3,** **S-C, U-4,5&6**	**S-A, U-1 & 2**
CC14	**S-A, U-2**	**S-A, U-1**	**S-B, U-1,2**	**S-C, U-1,2**
DSE3A	**S-A, U-3**	**S-A, U-2**	**S-A, U-1**	**S-A, U-4**
DSE4B	**S-B, U-1,2**	**S-A, U-1,2,3**	**S-C, U-2,3**	**S-C, U-1**

Sem-V_DSC (DSE, SEC,GE)

	SC	SB	DD	DM
DSE-1B- Lit. Criticism	**S-C, U-I**	**S-B, U-I**	**S-A, U-I**	********
SEC-4T- Indian Theatre	**S-D, U-1,2,3**	**S-A, U-1&2**	**S-C, U-1,2,**	**S-B, U-1**
GE-2T Basics of Sanskrit Linguistics	**S-C, U-1**	**S-D, U-1**	**S-B, U-1**	**S-A, U-1,2**

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Department of Zoology

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Semester wise Syllabus distribution (Session 2021-2022)

UG Honours Semester I

Name of the Teacher	Course with name of the subject /Nature	Unit/ Serial number
Dr. Rahul Kumar Datta	CC 2 – C2T Ecology	1,2
	CC 2 – C2P Ecology Lab	1,3 (Free CO_2 & Dissolved O_2)
Dr. Krishnendu Sinha	CC 1 – C1T Non chordates I	4,5
	CC 1 – C1P Non chordate Lab	3 (Cnidaria)
	CC 2 – C2T Ecology	3
	CC 2 – C2P Ecology Lab	2
Shri Sanjib Kumar Das	CC 1 – C1T Non chordates I	1,3
	CC 1 – C1P Non chordate Lab	3 (Porifera)
	CC 2 – C2T Ecology	5
Md Shariful Islam	CC 2 – C2T Ecology	4
	CC 2 – C2P Ecology Lab	3 (excluding Free CO_2 & Dissolved O_2), 4
Shri Sourav Barai	CC 1 – C1T Non chordates I	6,7
	CC 1 – C1P Non chordate Lab	4,5
Dr. Koushik Sen	CC 1 – C1T Non chordates I	2
	CC 1 – C1P Non chordate Lab	1,2

UG Honours Semester II

Name of the Teacher	Course with name of the subject /Nature	Unit/ Serial number
Dr. Rahul Kumar Datta	CC 3 – C3T Non chordates II	2,3(Classification only),7
	CC 3 – C3P Non chordates Lab	1 a,b (excluding Insect), 2,3,5
Dr. Krishnendu Sinha	CC 3 – C3T Non chordates II	4
	CC 4 – C4T Cell biology	4, 8(Extracellular matrix, Apoptosis, Necrosis)
	CC 4 – C4T Cell biology Lab	4
Shri Sanjib Kumar Das	CC 3 – C3T Non chordates II	5
	CC 3 – C3P Non chordate Lab	1 c
	CC 4 – C4T Cell biology	3,7
	CC 4 – C4T Cell biology Lab	2
Md Shariful Islam	CC 3 – C3T Non chordates II	3 (excluding Classification)
	CC 3 – C3P Non chordate Lab	1b (Insect only), 4
	CC 4 – C4T Cell biology	1,6
Shri Sourav Barai	CC 3 – C3T Non chordates II	6
	CC 3 – C3P Non chordate Lab	1d
	CC 4 – C4T Cell biology	2
	CC 4 – C4T Cell biology Lab	1
Dr. Koushik Sen	CC 3 – C3T Non chordates II	1
	CC 4 – C4T Cell biology	5,8 (Cell signaling to role of cAMP)
	CC 4 – C4T Cell biology Lab	3

Department of Zoology

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Semester wise Syllabus distribution (Session 2021-2022)

UG Honours Semester III

Name of the Teacher	Course with name of the subject /Nature	Unit/ Serial number
Dr. Debnarayan Roy	CC 6 – C6T Animal Physiology	4
	CC 6 – C6P Animal Physiology Lab	5
Dr. Rahul Kumar Datta	CC 5 – C5T Chordates	1,3,7
	CC 5 – C5P Chordates Lab	5
Dr. Krishnendu Sinha	CC 5 – C5T Chordates	4,5
	CC 5 – C5T Chordates Lab	2,3
	CC 6 – C6T Animal Physiology	3
	CC 7 – C7T Biochemistry	5 (Oxidative phosphorylation)
	CC 7 – C7P Biochemistry Lab	2,4
Shri Sanjib Kumar Das	CC 5 – C5T Chordates	6
	CC 5 – C5T Chordates Lab	4
	CC 6 – C6T Animal Physiology	1
	CC 6 – C6P Animal Physiology Lab	1,2,3,4
	CC 7 – C7T Biochemistry	4,5(Enzymes)
	CC 7 – C7P Biochemistry Lab	1(Carbohydrate),3
Md Shariful Islam	CC 5 – C5T Chordates	2,10
	CC 5 – C5P Chordates Lab	1
	CC 7 – C7T Biochemistry	2
	CC 7 – C7P Biochemistry Lab	5
Shri Sourav Barai	CC 5 – C5T Chordates	8
	CC 5 – C5P Chordates Lab	7
	CC 7 – C7T Biochemistry	1,3
	CC 7 – C7P Biochemistry Lab	1,6
Dr. Koushik Sen	CC 5 – C5T Chordates	9
	CC 5 – C5P Chordates Lab	6
	CC 6 – C6T Animal Physiology	2,5,6
	CC 6 – C6P Animal Physiology Lab	4,5
Smt. Sanchita Pan	CC 5 – C5P Chordates Lab	8
	SEC1 – SEC1T Apiculture	1,2,3,4,5
All the teachers (to be decided as mentor-mentee)	CC 5 – C5T Chordates Lab	9

Department of Zoology

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Semester wise Syllabus distribution (Session 2021-2022)

UG Honours Semester IV

Name of the Teacher	Course with name of the subject /Nature	Unit/ Serial number
Dr. Debnarayan Roy	CC8 – C8T Comparative anatomy	3 (Stomach), 5
Dr. Rahul Kumar Datta	CC8 – C8T Comparative anatomy	1,2,3(Dentition),8
	CC8 – C8P Comparative anatomy Lab	1
	CC9 – C9P Animal physiology Lab	1,3,4
	CC10 –C10P Immunology Lab	4
Dr. Krishnendu Sinha	CC8 – C8T Comparative anatomy	7
	CC9 – C9T Animal physiology	1
	CC9 – C9P Animal physiology Lab	2,5
	CC10 – C10T Immunology	8,10
	CC10 –C10P Immunology Lab	5
Shri Sanjib Kumar Das	CC8 – C8P Comparative anatomy Lab	2,3,4
	CC9 – C9T Animal physiology	3,4
	CC10 – C10T Immunology	4,5
Md Shariful Islam	CC8 – C8T Comparative anatomy	4
	CC10 – C10T Immunology	7,9
	CC10 –C10P Immunology Lab	3
Shri Sourav Barai	CC9 – C9T Animal physiology	2
	CC10 – C10T Immunology	2,3
	CC10 –C10P Immunology Lab	1
Dr. Koushik Sen	CC9 – C9T Animal physiology	5
	CC10 – C10T Immunology	1,6
	CC10 –C10P Immunology Lab	2
Smt. Sanchita Pan	CC8 – C8P Comparative anatomy Lab	5
	SEC2 – SEC2T Sericulture	1,2,3,4,5

Department of Zoology

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Semester wise Syllabus distribution (Session 2021-2022)

UG Honours Semester V

Name of the Teacher	Course with name of the subject /Nature	Unit/ Serial number
Dr. Debnarayan Roy	DSE2 – DSE2T Microbiology	9
Dr. Rahul Kumar Datta	CC12 – C12T Genetics	1,2,3
	CC12 – C12P Genetics Lab	1,4
	DSE2 – DSE2T Microbiology	1
Dr. Krishnendu Sinha	CC11–C11P Molecular biology Lab	2,3
	DSE1 – DSE1T Animal behaviour & Chronobiology	1,2,3,4,5
	DSE1 – DSE1T Animal behaviour & Chronobiology Lab	1,2,3,4,6,7
Shri Sanjib Kumar Das	CC11–C11T Molecular biology	1,6,7
	CC11–C11P Molecular biology Lab	1
	CC12 – C12T Genetics	5,6
	CC12 – C12P Genetics Lab	2,3
	DSE2 – DSE2T Microbiology	8
Md Shariful Islam	CC11–C11T Molecular biology	8
	CC12 – C12T Genetics	7
	DSE2 – DSE2T Microbiology	5,7
	DSE2 – DSE2T Microbiology Lab	6,7
Shri Sourav Barai	CC11–C11T Molecular biology	2,3,4,5
	DSE2 – DSE2T Microbiology	4
	DSE2 – DSE2T Microbiology Lab	5
Dr. Koushik Sen	CC12 – C12T Genetics	4
	DSE2 – DSE2T Microbiology	3,6
	DSE2 – DSE2T Microbiology Lab	1,2,3,4
Smt. Sanchita Pan	DSE2 – DSE2T Microbiology	2
Concerned teachers (to be decided after field visit)	DSE1 – DSE1T Animal behaviour & Chronobiology	5

Department of Zoology

Jhargram Raj College

Semester wise Syllabus distribution (Session 2021-2022)

UG Honours Semester VI

Name of the Teacher	Course with name of the subject /Nature	Unit/ Serial number
Dr. Debnarayan Roy	DSE4 – DSE4T Biology of insects	2
	DSE – DSE3P Endocrinology Lab	3
Dr. Rahul Kumar Datta	CC14 – C14T Evolutionary biology	2,8
	DSE4 – DSE4T Biology of insects	6
	DSE4 – DSE4P Biology of insects Lab	7
Dr. Krishnendu Sinha	CC13–C13T Developmental biology	1
	CC14 – C14T Evolutionary biology	7,9
	CC14 – C14T Evolutionary biology Lab	2
	DSE – DSE3P Endocrinology Lab	5
Shri Sanjib Kumar Das	CC13–C13T Developmental biology	3
	CC13–C13P Developmental biology Lab	3,4
	CC14 – C14T Evolutionary biology	5
	DSE – DSE3T Endocrinology	4
Md Shariful Islam	CC13–C13T Developmental biology	4
	CC14 – C14T Evolutionary biology	4
	DSE4 – DSE4T Biology of insects	1,3,4,5
	DSE4 – DSE4P Biology of insects Lab	2,3,4,5,6
Shri Sourav Barai	CC13–C13T Developmental biology	2
	CC13–C13P Developmental biology Lab	1,2
	CC14 – C14T Evolutionary biology	1,3
	CC14 – C14T Evolutionary biology Lab	1,3,4
	DSE – DSE3T Endocrinology	3
Dr. Koushik Sen	CC13–C13T Developmental biology	5
	CC14 – C14T Evolutionary biology	6
	DSE – DSE3T Endocrinology	1,2,4
	DSE – DSE3P Endocrinology Lab	1,2,3,4
Smt. Sanchita Pan	DSE4 – DSE4T Biology of insects	6,7
	DSE4 – DSE4P Biology of insects Lab	1

Department of Zoology

Jhargram Raj College

Semester wise Syllabus distribution (Session 2021-2022)

UG Honours GENERIC Semester III

Name of the Teacher	Course with name of the subject /Nature	Unit/ Serial number
Md Shariful Islam	GE3 – GE3T Aquatic biology	1
	GE3 – GE3P Aquatic biology Lab	2,3,5
Shri Sourav Barai	GE3 – GE3T Aquatic biology	4
	GE3 – GE3P Aquatic biology Lab	4,5
Dr. Koushik Sen	GE3 – GE3T Aquatic biology	3
	GE3 – GE3P Aquatic biology Lab	1,5
Smt. Sanchita Pan	GE3 – GE3T Aquatic biology	2
	GE3 – GE3P Aquatic biology Lab	1,2,3,4,5

UG Honours GENERIC Semester III

Name of the Teacher	Course with name of the subject /Nature	Unit/ Serial number
Md Shariful Islam	GE4 – GE4T Insect vectors & Diseases	1,5,6
	GE4 – GE4P Insect vectors & Diseases Lab	1
Shri Sourav Barai	GE4 – GE4T Insect vectors & Diseases	2
	GE4 – GE4P Insect vectors & Diseases Lab	2
Dr. Koushik Sen	GE3 – GE3T Aquatic biology	3
	GE3 – GE3P Aquatic biology Lab	3
Smt. Sanchita Pan	GE4 – GE4T Insect vectors & Diseases	4,7
	GE4 – GE4P Insect vectors & Diseases Lab	Submisssion of Project report

Department of Zoology

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Semester wise Syllabus distribution (Session 2021-2022)

UG General Semester I (DSC1A)

Name of the Teacher	Course with name of the subject /Nature	Unit/ Serial number
Shri Sanjib Kumar Das	CC1 – DSCIAT Animal diversity	2,3,14
	CC1 – DSCIAP Animal diversity (Practical)	1(Porifera, Cnidaria, Reptilia),2 (Sycon),3
Md Shariful Islam	CC1 – DSCIAT Animal diversity	7,10,11
	CC1 – DSCIAP Animal diversity (Practical)	1 (Arthropoda, Protochordata, Agnatha)
Shri Sourav Barai	CC1 – DSCIAT Animal diversity	4,5,9,15
	CC1 – DSCIAP Animal diversity (Practical)	1 (Helminth, Echinodermata, Aves),2 (Helminth)
Dr. Koushik Sen	CC1 – DSCIAT Animal diversity	1,6,17
	CC1 – DSCIAP Animal diversity (Practical)	1(Protozoa, Annelida, Mammalia)
Smt. Sanchita Pan	CC1 – DSCIAT Animal diversity	8,12,13
	CC1 – DSCIAP Animal diversity (Practical)	1(Mollusca, Agnatha, Fish)

UG General Semester II (DSC1B)

Name of the Teacher	Course with name of the subject /Nature	Unit/ Serial number
Md Shariful Islam	CC2 – DSCIBT Comparative Anatomy & Developmental Biology	10,11
	CC2 – DSCIBP Comparative Anatomy & Developmental Biology (Practical)	3,4
Shri Sourav Barai	CC2 – DSCIBT Comparative Anatomy & Developmental Biology	8,9
	CC2 – DSCIBP Comparative Anatomy & Developmental Biology (Practical)	2
Dr. Koushik Sen	CC2 – DSCIBT Comparative Anatomy & Developmental Biology	6,7
	CC2 – DSCIBP Comparative Anatomy & Developmental Biology (Practical)	5
Smt. Sanchita Pan	CC2 – DSCIBT Comparative Anatomy & Developmental Biology	1,2,3,4,5
	CC2 – DSCIBP Comparative Anatomy & Developmental Biology (Practical)	1

Department of Zoology

Jhargram Raj College

Semester wise Syllabus distribution (Session 2021-2022)

UG General Semester III (DSC1C/SEC1)

Name of the Teacher	Course with name of the subject /Nature	Unit/ Serial number
Md Shariful Islam	CC3 – DSCICT Physiology & Biochemistry	5,8
	CC3 – DSCICP Physiology & Biochemistry (Practical)	1
	SEC – SEC1T Apiculture	1
Shri Sourav Barai	CC3 – DSCICT Physiology & Biochemistry	7,9,10
	CC3 – DSCICP Physiology & Biochemistry (Practical)	5,6
	SEC – SEC1T Apiculture	2
Dr. Koushik Sen	CC3 – DSCICT Physiology & Biochemistry	1,6
	CC3 – DSCICP Physiology & Biochemistry (Practical)	2
	SEC – SEC1T Apiculture	3
Smt. Sanchita Pan	CC3 – DSCICT Physiology & Biochemistry	2,3,4
	CC3 – DSCICP Physiology & Biochemistry (Practical)	3,4
	SEC1 – SEC1T Apiculture	4,5

UG General Semester IV (DSC1D/SEC2)

Name of the Teacher	Course with name of the subject /Nature	Unit/ Serial number
Shri Sanjib Kumar Das	CC4 – DSCIDT Genetics & Evolutionary biology	1,2,3,4
	CC4 – DSCIDP Genetics & Evolutionary biology (Practical)	1,2,3
Md Shariful Islam	CC4 – DSCIDT Genetics & Evolutionary biology	6,12
	CC4 – DSCIDP Genetics & Evolutionary biology (Practical)	5
Shri Sourav Barai	CC4 – DSCIDT Genetics & Evolutionary biology	9,11
	CC4 – DSCIDP Genetics & Evolutionary biology (Practical)	4
Dr. Koushik Sen	CC4 – DSCIDT Genetics & Evolutionary biology	5,10
	CC4 – DSCIDP Genetics & Evolutionary biology (Practical)	6
Smt. Sanchita Pan	CC4 – DSCIDT Genetics & Evolutionary biology	7,8
	CC4 – DSCIDP Genetics & Evolutionary biology (Practical)	7
	SEC2 – SEC2T Aquarium Fish Keeping	1,2,3,4,5

Department of Zoology

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Semester wise Syllabus distribution (Session 2021-2022)

UG General Semester V (DSE1/SEC3)

Name of the Teacher	Course with name of the subject /Nature	Unit/ Serial number
Md Shariful Islam	DSE1 – DSE1T Aquatic biology	1
	DSE1 – DSE1P Aquatic biology (Practical)	2,3,5
Shri Sourav Barai	DSE1 – DSE1T Aquatic biology	4
	DSE1 – DSE1P Aquatic biology (Practical)	4,5
Dr. Koushik Sen	DSE1 – DSE1T Aquatic biology	3
	DSE1 – DSE1P Aquatic biology (Practical)	1,5
Smt. Sanchita Pan	DSE1 – DSE1T Aquatic biology	2
	DSE1 – DSE1P Aquatic biology (Practical)	5
	SEC 3 – SEC3T Medical diagnostics	1,2,3,4,5,6

UG General Semester VI (DSE2/SEC4)

Name of the Teacher	Course with name of the subject /Nature	Unit/ Serial number
Md Shariful Islam	DSE2 – DSE2T Insect, Vector & Diseases	1,4,5
	DSE2 – DSE2P Insect, Vector & Diseases (Practical)	1
Shri Sourav Barai	DSE2 – DSE2T Insect, Vector & Diseases	2
	DSE2 – DSE2P Insect, Vector & Diseases (Practical)	3
Dr. Koushik Sen	DSE2 – DSE2T Insect, Vector & Diseases	3
	DSE2 – DSE2P Insect, Vector & Diseases (Practical)	3
Smt. Sanchita Pan	DSE2 – DSE2T Insect, Vector & Diseases	4,6
	DSE2 – DSE2P Insect, Vector & Diseases (Practical)	4
	SEC 4 – SEC4T Sericulture	1,2,3,4,5,6

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Semester wise Syllabus distribution (Session 2021-2022)

PG Semester I

Name of the Teacher	Course No. & Unit	Serial number in syllabus
Dr. Rahul Kumar Datta	ZOO 101.1 Non-chordates	1-7
	ZOO 101.2 Chordates	1,2
	ZOO 195 Practical	1(i)- Identification
Dr. Krishnendu Sinha	ZOO 101.2 Chordates	3-6
	ZOO 102.1 Histochemistry	1-6
	ZOO 195 Practical	2, 3(a, b, d, e)
	ZOO 196 Practical	2
Shri Sanjib Kumar Das	ZOO 102.2 Animal physiology	1,2,4
	ZOO 104.2 Cytogenetics	1-4
	ZOO 196 Practical	3a,4
Md Shariful Islam	ZOO 104.1. Cell biology	1-7
	ZOO 195 Practical	1(ii), 3c
	ZOO 196 Practical	3b
Shri Sourav Barai	ZOO 103.2 Methods in biology	1-3
	ZOO 195 Practical	4
	ZOO 196 Practical	1
	DSE – DSE3T Endocrinology	3
Dr. Koushik Sen	ZOO 102.2 Animal physiology	3
	ZOO 103.1 Immunology	1-6
	ZOO 195 Practical	3(a, b, d, e)
	ZOO 196 Practical	1,3b

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PG Semester II

Name of the Teacher	Course No. & Unit	Serial number in syllabus
Dr. Debnarayan Roy	ZOO 202.1 Biophysics	4
	ZOO 203.2 Parasitology	3
Dr. Rahul Kumar Datta	ZOO 201.1 Ecological principles	1-4
	ZOO 203.2 Parasitology	1
	C-ZOO204.1 Wildlife & Environmental management (CBCS)	a-f
	ZOO 295 Practical	1,2
Dr. Krishnendu Sinha	ZOO 201.1 Biosystematics	1-8
	ZOO 201.1 Ecological principles	5
	ZOO 295 Practical	3
	ZOO 296 Practical	2
Shri Sanjib Kumar Das	ZOO 202.1 Biophysics	6
	ZOO 202.2 Biochemistry	4-6
	ZOO 203.1 Molecular biology	1-4
	ZOO 295 Practical	4(a, b, g)
Md Shariful Islam	ZOO 202.1 Biophysics	5
	ZOO 202.2 Biochemistry	1
	ZOO 295 Practical	4(d, f)
	ZOO 296 Practical	1(c) - Identification
Shri Sourav Barai	ZOO 202.1 Biophysics	1
	ZOO 202.2 Biochemistry	7
	ZOO 295 Practical	4e
	ZOO 296 Practical	1a
Dr. Koushik Sen	ZOO 202.1 Biophysics	3
	ZOO 202.2 Biochemistry	2,3
	ZOO 203.2 Parasitology	2, 4-7
	ZOO 295 Practical	4c
	ZOO 296 Practical	1b
Smt. Sanchita Pan	C-ZOO204.1 Wildlife & Environmental management (CBCS)	g-j
	C-ZOO204.2 Aquainformtics	1-4

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Semester wise Syllabus distribution (Session 2021-2022)

PG Semester III

Name of the Teacher	Course No. & Unit	Serial number in syllabus
Dr. Debnarayan Roy	ZOO 301.1 Basic & applied Entomology	2
Dr. Rahul Kumar Datta	ZOO 303B.1 Biodiversity & Conservation Ecology	Biodiversity, wildlife ecology, conservation of biodiversity, endemic avifauna of India, Tools & techniques for wildlife census & survey
	ZOO 303B.2 Aquatic ecology	1-4
	ZOO 395B Ecology Practical -I	1-7
Dr. Krishnendu Sinha	ZOO 302.1 Molecular evolution	1,2
	ZOO 395 Practical	3
Shri Sanjib Kumar Das	C-ZOO 304.1 Genetics (CBCS)	1-5
Md Shariful Islam	ZOO 301.1 Basic & applied Entomology	1, 3-6
	ZOO 395 Practical	1
Shri Sourav Barai	ZOO 301.2 Ecotoxicology	1-5
	ZOO 395 Practical	2
Dr. Koushik Sen	ZOO 302.2 Microbiology	1-7
	ZOO 395 Practical	4
Smt. Sanchita Pan	C-ZOO 304.2 Haematology (CBCS)	1-5

PG Semester IV

Name of the Teacher	Course No. & Unit	Serial number in syllabus
Dr. Debnarayan Roy	ZOO 401.1 Environmental pollution & management	2
Dr. Rahul Kumar Datta	ZOO 403B.1 Systems ecology	1-6
	ZOO 403B.2 human ecology	1-6
	ZOO 495B Ecology Practical -II	1-8
Dr. Krishnendu Sinha	ZOO 401.2 biostatistics	1-12
	ZOO 494 Practical	2
Shri Sanjib Kumar Das	ZOO 401.1 Environmental pollution & management	5
Md Shariful Islam	ZOO 402.1 Developmental biology	1, 2
	ZOO 494 Practical	3
Shri Sourav Barai	ZOO 401.1 Environmental pollution & management	1,6
	ZOO 402.1 Developmental biology	3
	ZOO 494 Practical	1
Dr. Koushik Sen	ZOO 402.2 Neuroendocrinology	1-5
	ZOO 494 Practical	4
Smt. Sanchita Pan	ZOO 401.1 Environmental pollution & management	3,4
All the teachers (to be decided as mentor-mentee)	ZOO 496B	PROJECT/DISSERTATION