

Fourth		Hard Core							
	HCT4.1	Inorganic Chemistry-IV	80	20	100	4	0	0	4
	HCT4.2	Physical Chemistry-IV	80	20	100	4	0	0	4
		Soft Core (Any One)							
	SCT4.1	Analytical Chemistry-IV	80	20	100	4	0	0	4
	SCT4.2	Special Topics in Org. Chem.	80	20	100	4	0	0	4
		Practical							
	HCP4.1	Inorganic Chemistry Practical- IV	40	10	50	0	0	4	2
	HCP4.2	Physical Chemistry Practical-IV	40	10	50	0	0	4	2
		Soft Core (Any One)							
	SCP4.1	Analytical Chemistry Practical-IV	40	10	50	0	0	4	2
	SCP4.2	Organic Chemistry Practical -IV	40	10	50	0	0	4	2
	HCMP4.3	Major Project	120	30	150		0	12	12
		Total FOR Fourth Semester	480	120	600				24

L = Lecture; T = Tutorials; P = Practical; 4 Credits of Theory = 3 hrs. teaching , 1hr. tutorials per week. 2 Credits of Practical = 4 hours Practicals per week; Scheme of Practical Evaluation: Expts-30 Marks, Viva-voce-5 Marks, Record-5 Marks = 40 Marks and IA 10 marks = 50 marks.
Major Project: Evaluation-90 Marks , Viva-voce-30 Marks and IA 30 Marks = 150 Marks.

Semester - IV

HCT 4.1: Inorganic Chemistry – IV

[64 Hours]

UNIT-I

Flame photometry and Atomic absorption spectrometry: Energy level diagram – atomic absorption spectra. Flame characteristics, flame atomizers and electrothermal atomization. Comparison of spectral interferences, chemical and physical interferences in Flame Photometry and AAS. Use of organic solvents. Quantitative techniques – calibration curve procedure and the standard addition technique. Typical commercial instruments for Flame Photometry and AAS, Applications. Qualitative analysis and quantitative evaluations. Relative detectabilities of atomic absorption and flame emission spectrometry.

Inductively coupled plasma-Atomic emission spectroscopy: Limitations of flame emission spectroscopy, principles of plasma spectroscopy, process of atomisation and excitation, plasma as an excitation source, inductively coupled plasma source, ICP-AES instrumentation, applications of plasma spectroscopy, comparison of ICP-AES with AES, comparison of AFS, AAS and ICP-AES.

[16 Hours]

UNIT-II

Radioanalytical Methods:

Radioactive tracers, principles and applications. Isotopic dilution analysis – direct and inverse; special analytical applications and radiometric titrations.

Neutron activation analysis: Principle, instrumentation, applications and limitations.

Radiochromatography and radio immunoassay- principle and applications.

Thermal methods: Thermogravimetry- instrumentation, factors affecting thermogram, applications.

Differential thermal analysis (DTA) - theories, apparatus, and applications.

Differential scanning calorimetry (DSC) – Introduction, instrumentation and applications.

Thermometric titrations and applications.

[16 Hours]

UNIT-III

Mossbauer Spectroscopy: Basic principle, spectral parameters, spectral display. Doppler effect, Zeeman splittings, isomer shift, Quadrupole splitting, magnetic interaction. Mossbauer spectrometers, components.

Applications of Mossbauer techniques to the studies of (i) Bonding and Structure of Fe^{+2} and Fe^{+3} compounds (ii) Detection of oxidation states.

NQR Spectroscopy: Consequence of nuclear spin larger than $\frac{1}{2}$, prolate and oblate nucleus, nuclear quadrupolar charge distribution-theory and instrumentation, relationship between electric field gradients and molecular structure, applications and interaction of eQq data. Effect of crystal lattice on the magnitude of eQq. Structural information from NQR spectra.

[16 Hours]

UNIT-IV

Electron Spin Resonance Spectroscopy: Basic principles, zero field splitting, Kramer's degeneracy, factors affecting g -values. Interpretation of g -values. Isotopic and anisotropic hyperfine coupling constants. Spin Hamiltonian, spin densities and Mc Connel relationship. Measurement techniques.

ESR spin – orbit coupling and significance of g tensors application to first row transition metal complexes.

Photoelectron Spectroscopy: Basic principles, photo-electric effect, ionization process, Koopman's theorem. Photoelectron spectra of simple molecules, chemical information from ESCA, instrumentation and applications. Auger electron spectroscopy principles, instrumentation and applications.

[16 Hours]

Books Recommended:

1. Advanced Inorganic Chemistry - F.A. Cotton and G. Wilkinson (John Wiley).
2. Inorganic Chemistry - J. Huheey, Harper and Rao.
3. Principles of Instrumental Analysis - Skoog, Hollar and Nieman (Harcourt Asia Pvt ltd., India New Delhi 5th Edition, 1998).
4. Instrumental Methods of Chemical Analysis – Chatwal and Anand (5th Edition).
5. Organic Chemistry – Wiliam Kemp (3rd Edition ELBS 1991).
6. Organic Spectroscopy – P.S. Kalasi (Tata Mc. Graw Hill 1993).
7. NMR, NQR, EPR and Mossbauer Spectroscopy in Inorganic Chemistry – R.V. Parish, Ellis Horwood.
8. Instrumental Method of Analysis – Willard, Mserit and Dean.
9. Instrumental Methods of Chemical Analysis –B.K.Sharma(Goel publishing house Meerut, 2000) .
10. Introduction to Spectroscopy- Pavia, Lampman and Kriz.
11. Strctural Methods in Inorganic Chemistry – E.A. Ebsworth,D.W.H.Ranbin and S.Cradock, ELBS.
12. Instrumental Methods of Chemical Analysis - H. Kaur.

HCP 4.1: Inorganic Chemistry Practicals-IV

[64 Hours]

- 1 Determination of iron using 1, 10- phenanthroline as a reagent by Spectrophotometry.
- 2 Determination of zirconium using alizarin red s as a reagent by Spectrophotometry.
- 3 Determine the composition of complex of copper ethylenediamine by spectrophotometry
- 4 Determination of iron by Potentiometrically by using ceric ammonium sulphate and potassium dichromate.
- 5 Determination of mixture of halides by Potentiometrically.

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- 6 Determination of mixture of halides by conductometrically.
- 7 Determination of strength of acids by pH metrically.
- 8 Flame photometry determination of following metal ions from different samples:
 - a) sodium b) potassium c) calcium d) lithium e) sodium and potassium in a mixture.

Books Recommended:

1. Vogel's Text Book of Quantitative Inorganic Analysis- J. Basett, R. C. Denney, H. Jeffery and J. Mendham, Longmans, Green and company Ltd.
2. Practical Inorganic Chemistry-G. Pass and H. Sutcliff, Chapman and Hall Ltd.(1968).
3. General Chemistry Experiments-A. J. Elias, University Press.
4. Principles of Instrumental Analysis - Skoog, Holler and Nieman (Harcourt Asia Pvt ltd., India New Delhi 5th Edition, 1998).
5. Instrumental Methods of Chemical Analysis – Chatwal and Anand (5th Edition).

HCT 4.2: Physical Chemistry-IV

[64 Hours]

UNIT-I

Electrochemistry and Photochemistry:

Ion-solvent interaction, Born model, solvation number and their determination, over voltage, Decomposition potential, Butler-Volmer equation, Tafel equation, Factors important in elucidating electrode reaction and some electrochemical systems of technological importance, Electroplating.

Electrochemical energy systems: Introduction, fundamentals of batteries, primary and secondary batteries, fuel cells, types of fuel cells,

Interaction of radiation with matter, review of laws of photochemistry, Jablonski's diagram, radiative and non-radiative processes. Stern – Volmer equation, photophysical kinetics of uni and bimolecular processes. Photolysis of water. Theories of Fluorescence, Phosphorescence and Bioluminescence.

[16 Hours]

UNIT-II

Diffraction Studies:

X-ray diffraction: Crystal systems, crystallographic axes and angles, nomenclature and point groups. Space lattice, Reciprocal lattice, Bravais lattice, Unit cell, Weiss indices, Miller indices, Bragg's equation, Single crystal rotation methods, Powder methods-analytical procedures for powder diffraction analysis, structure factor. Fourier series, Fourier refinement. Phase problem.

Electron diffraction: Introduction, Scattering intensity versus scattering angle, Wierl's equation, Radial distribution function, Refinement radial distribution function, Rotation sector method.

Neutron diffraction: Introduction, Scattering of neutrons by solids and liquids. Difference between neutron and X-ray diffraction.

[16 Hours]

UNIT-III

Molecular Spectroscopy:

Characterization of electromagnetic radiation, quantization of energy levels, rotational spectroscopy, classification of molecules based on their moment of inertia, rotation of rigid diatomic molecules and non rigid diatomic molecules and rotational energy levels.

Infrared Spectra: Vibration of diatomic molecule, simple harmonic oscillator model, vibrational energy levels and vibrational spectra, The anharmonic oscillator model, fundamental bands, overtones and hot bands.

Vibrational and rotational spectra of diatomic and polyatomic molecules and its applications to CO, CO₂ and H₂O molecules. Overtones and combination frequencies PQR branches, Born-Oppenheimer approximation.

Electronic spectra of diatomic molecules, Electron transition in diatomic molecule V' and V'' progressions. Frank-Condon principle, rotational fine structure of electronic vibrations Fortrate diagrams and pre dissociation.

Raman Spectroscopy: Introduction, stokes and anti stokes lines, classical and quantum theory of Raman Effect, Raman activity of vibration, rotational and vibrational Raman spectra, mutual exclusion principle, Resonance Raman Spectroscopy.

[16 Hours]

UNIT-IV

Polymer Science and Technology:

Determination of molecular weight by end group analysis and GPC method, determination of chain dimension from light scattering technique.

Understanding of thermo mechanical behavior from TMA and DMA techniques. Physical properties v/s applications: plastic, fibers, elastomers, and additives. Swelling of polymers, stress strain behavior, viscoelastic behavior and elastomers.

Conduction polymers: synthesis through chemical oxidation understanding of structure and properties of polyaniline, polypyrrole and polythiophene,

[16 Hours]

Books Recommended:

1. Modern aspects of electrochemistry Vol-I & Vol-II- J.O.M.Bockris & A.K.N Reddy
2. Electrochemistry by Glasstone
3. Heterogeneous catalysis- G.C.Bond
4. The basic applications of heterogeneous catalysis- Michael Bowker.
5. Fundamentals of Molecular Spectroscopy- CN Banwell & Mc Cash
6. Introduction to molecular Spectroscopy- G.M.barrow
7. Polymer Chemistry- Billayer
8. Polymer Chemistry- P.J.Flory
9. Physical chemistry of macromolecules by D.D.Deshpande
10. Polymer Science- Gowarikar
11. Physical chemistry- P.W. Atkins
12. Chemical Kinetics- Laidler

HCP 4.2: Physical Chemistry Practical-IV [64 Hours]

Part-I

1. Determination of stability constant of the complex formed between Fe^{3+} and Salicylic acid-5-SSA.
2. Determination of pKa of given indicator.
3. Determination of specific and molar rotation of optically active substances and to find out the intrinsic rotation.
4. Determination of surface tension of liquid by stalagnometer.
5. Determination of molecular weight of given polymer(Polyvinyl alcohol, polystyrene, methyl acrylate etc) using viscometer.
6. Determination of Ka values of given samples by pH-metric titration.

Part-II

1. Titration of mixture of KCl and KI against AgNO_3 by conductometry.
2. Titration of o-phosphoric acid against NaOH by pH meter.
3. Determination of solubility of sparingly soluble salt by Potentiometry.
4. Kinetics saponification of ethyl acetate by conductometry.
5. Kinetics of decomposition of benzene diazonium chloride and determination E_a and
6. Thermodynamic parameters
7. Determination of ionic product of water and study of effect of temperature.
8. Elucidation of structure from the given spectroscopic data.

9. Note: the number of practicals may be modified depending upon the facilities and requirements.

Books Recommended:

1. Fridley's Practical Physical Chemistry- B.P.levitt.
2. Advanced Practical Physical Chemistry- G.B.Yadav
3. Experiments Practical Physical Chemistry- Shomaker
4. Systematic experimental Physical Chemistry- S.W.Rajbhoj & T.K.Chondeker
5. Senior Physical Chemistry Practical- Kholsa et.al

SCT 4.1: Analytical Chemistry-IV

[64 Hours]

UNIT-I

Nephelometry and Turbidometry : Light scattering, principles of nephelometry and turbidometry measurements, instruments, general procedure for operating nephelometer, surface scatter turbidometer, turbidometric titrations, applications.

Polarometry: Introduction polarized light, optical activity, applications of polarimetry in saccharimetry.

Optical Rotator Dispersion and Circular Dichroism: Rotatory dispersion, instrumentation for ORD and CD, Cotton effect, Anomalous ORD curves, Octant rule, applications of Octant rule, applications of ORD and CD. Advantages of CD over ORD, limitations of ORD and CD.

[16 Hours]

UNIT -II

Fluorimetry and Phosphorimetry : Principle (laws governing phosphorescence and fluorescence); Instrumentation, quantitative analysis, application in real sample analysis (e.g. in environment, biology, medicine, rock, minerals, etc.)

Chemiluminescence Methods: Principle, Apparatus, Quantitative Chemiluminescence - Gas phase and liquid phase chemiluminescent analysis and titrations.

[16 Hours]

UNIT-III

Automated systems: An overview, definition, distinction between automatic and automated systems, advantages and disadvantages by automation, types of automated techniques. Non-discrete techniques, segmented flow methods and basic equipment, special techniques and devices, theoretical considerations and problems, applications. Single/channel and multi-channel auto analysers, BUN analysers, automatic glucose analyser and ammonia in water analyser, COD analyser, CFA in industry. Non-segmented flow methods: Flow injection analysis, principles, types of dispersions, factors affecting dispersion, applications of small, medium and large dispersions, stopped flow methods, flow injection titrations. Discrete methods: Centrifugal fast scan analyser, automatic multipurpose analysers, automatic elemental analyser, automated analyser based on multilayer film-principles, film structure, instrumentation and applications. Comparison of discrete and non-discrete methods. Advantages of flow injection measurements over continuous flow measurements.

[16 Hours]

UNIT -IV

HYPHENATED TECHNIQUES : Need for hyphenation, Interfacing devices and applications of GC - MS, GC - IR, MS-MS, HPLC - MS, ICP -MS, ICP - OES.

[16 Hours]

Books Recommended:

1. Pharmaceutical Analysis. T. Higuchi and E. B. Hanssen, John Wiley and Sons, New York.
2. Quantitative Analysis of drugs.P.D.Sethi, 3rd edition. CBS Publishers, New Delhi, 1997.
3. Practical Clinical biochemistry methods and interpretations. R. Chawla, J.P.Brothers Medical Publishers (P), 1995.
4. Laboratory manual in biochemistry. J. Jayaraman, New Age International Publishers, New Delhi, 1981.
5. Pharmaceutical Analysis. Modern methods – Part A and B, Edited by James W. Munson.
6. Hawk's physiological chemistry. Edited by B.L.Oser, 14th edn, Tata McGraw Hill, (1976).
7. The Essentials Forensic Medicine and Toxicology.Dr. K. S. Narayana Reddy.
8. Practical clinical Biochemistry. Harold Varley and Arnold, Heinmann, 4th edn.
9. Analysis of Foods. H. E. Cox.
10. Chemical Analysis of Foods. H. E. Cox and Pearson.
11. Handbook of Modern Pharmaceutical Analysis.Vol.3, Eds. S. Ahuja and S. Scypinski, Academic Press, Tokyo, 2001.
12. A First Course in Food Analysis. A.Y Sathe, New Age International (P) Limited, Publishers.
13. Methods in Food Analysis 2nd edn. Edited by Mayanard A. Joslyn, Academic Press.
14. Fundamental of Analytical Chemistry. D.A.Skoog, D.M.West, Holler and Crouch 8th edition, 2005, Saunders College Publishing, New York.
15. Analytical Chemistry. G.D. Christian, 5th edn, 2001 John Wiley & Sons, Inc, India.
16. Pearson's Composition and Analysis of Foods, 9th edn, Ronald S. Kirk, Ronald Sawyer, Addison- Wesley An imprint of Addison Wesley Longman, Inc.

17. The Chemical Analysis of Foods and Food products. 3rd edn. Morris B. Jacobs, Robert E. Krieger publishing co.inc.
18. Food Analysis, Theory and Practice, 3rd edn. Yeshajahu Pomeranz and Clifton E. Meloan, CBS Publishers & Distributors, New Delhi
19. The Quantitative Analysis of Drugs, 3rd edn. D. C. Garratt, science Paperbacks
20. British Pharmacopeia Vol. I & II.
21. Instrumental methods of analysis. L. L. Meritt, J. A. Dean, F.A., settle 6th Edn. (Van Nostnoand).
22. Principles of Instrumental Analysis. D. S. Kooj (Sander Colley).
23. Fundamentals of Analytical Chemistry. Skoog, West, Holler, 7th Edn. Harcourt Agra. Publication Harcourt College Publishers.
24. Principles of instrumental analysis. Skoog, Haller, Nieman, 5th Edn. Harcourt Agra. Publication Harcourt College Publishers.
25. Treatise an analytical chemistry. F. J. Kohthiff & F. T. Elhiy, (M. Interscience).
26. Nuclear and Radiochemistry. G. Dridelandey, J. M. Millar, M. M. Keondy & E. S. Macias (John Willey).
27. Essentials of Nuclear Chemistry. H. J. Arnikaar (Wiley Eastern)
28. Text Book of quantitative chemical analysis. A.I. Vogel (ELBS)
29. Standard Methods of chemical analysis. Wekin E. J

SCP 4.1: Analytical Chemistry Practical-IV

[64 Hrs]

1. Turbidometric determination of sulphate
2. Flame photometric determination of Na⁺ & K⁺ concentration in tap water.
3. Flame photometric determination of Ca & Mg
4. Identification and determination of Cd²⁺/Pb²⁺/Zn²⁺ by polarography
5. Determine the amount of calcium, magnesium and zinc in face powder by using chromatographic methods.
6. Separation of Lead (II) and Mercury (II) by Partition Chromatography
7. Separation of Chlorophyll Pigments by Column Chromatography
8. Demonstration of HPLC/GC interpretation of Behavior by plots
9. Spectrophotometric determination of NO₂⁻-N in water sample
10. Determination of As in ant acid control preparation by redox titration

Books Recommended:

1. Quantitative Analysis of drugs. P.D.Sethi, 3rd edition. CBS Publishers, New Delhi, 1997.
2. The Quantitative Analysis of Drugs, 3rd edn. D. C. Garratt, science Paperbacks.
3. A First Course in Food Analysis. A.Y Sathe, New Age International (P) Limited, Publishers.
4. The Chemical Analysis of Foods and Food products. 3rd edn. Morris B. Jacobs, Robert E. Krieger publishing co.inc.
5. British Pharmacopeia Vol. I & II.

SCT 4.2: Organic Chemistry – IV (Special Topics In Organic Chemistry)

[64 Hours]

UNIT-I

Photochemistry:

Activation of thermal and photochemical reactions. Light absorption and excitation, singlet and triplet states. Morse curves, Franck-Condon principle. De excitation processes, Jablonski diagram, photosensitization (donor, acceptor concept, resonance, collision and transfer). Chemical processes, quantum yield and quantum efficiencies. Variation in singlet and triplet states. Phenomena of optical pumping, Remote functionalization (Barton reaction).

Photochemistry of olefins: Cis–trans isomerisation, (2+2) cycloaddition, De Mayo cycloaddition (2+2) photochemical and rearrangements. Reactions of conjugated olefins and di-II methane rearrangements.

Photochemistry of Ketones: Excited states of ketones, Norrish type –I and type –II cleavages. Pattero-Buchi reaction, α,β –unsaturated ketones, (2+2) addition, cis-trans isomerization. Rearrangements of cyclohexadienones.

Photochemistry of aromatic Compounds: Photorearrangement of benzene and its derivatives, cycloaddition of benzenes and substitutions of benzene derivatives.

Photochemical oxidation and reduction: Cycloadditions of (singlet) molecular oxygen, oxidative coupling, photoreduction by hydrogen abstraction.

[16 Hours]

UNIT-II

Pericyclic reactions:

Definition of various terms, Pericyclic, electrocyclic, cycloaddition, sigmatropic, chelotropic and ene reaction. Con-rotatory, disrotatory, suprafacial, antarafacial, HOMO, LUMO etc.

Symmetry properties of molecular orbitals of ethylene, butadiene, hexatriene, vinyl radicals, anion, cation, pentadienyl radical, anion and cation. Conservation of orbital symmetry and the photochemical concerted processes. Formulation of selection rule by 1) orbital correlation diagrams 2) HOMO-LUMO method and 3) Huckel-Mobius aromaticity approach (all qualitative method only) for electrocyclic reactions of (butadiene-cyclobutene and hexatriene- cyclo hexadiene interconversions) Cycloadditions (2+2), (2+4) and examples of other higher systems.

Sigmatropic reactions: (1,3), (1,5), and (3,3) sigmatropic reactions, Cope and Claisen rearrangement reactions.(Several suitable examples are to be taken for each class of transformation). Chelotropic and ene reactions. (Several examples in each class)

[16 Hours]

UNIT-III

Organometallics and non-metallic Reagents :

Organo magnesium halides, organo lithium reagents, organo copper, organo zinc, organo cadmium, organo mercury, organo silicon, organo tin, organo palladium compound.

Metal carbonyl complexes of Fe, Co and Ni. Pentacarbonyl iron, octocarbonyl dicobalt, tetracarbonyl nickel. Organo phosphorus compounds.

[16 Hours]

UNIT-IV

Green chemistry:

Modern Technology: Modern techniques in organic synthesis. Brief outline of microwave. Ultrasound, clay catalyzed techniques and uses of ionic liquids and polymer supports in organic synthesis. Phase-transfer catalysts & Crown-ethers. Super critical fluid extractions

Microwave synthesis: Introduction, reaction vessel, reaction medium, concept, specific effects, atom efficiency, percentage atom utilization, advantage and limitation. N-alkylation and alkylation of active methylene compounds. Condensation of active methylene compounds with aldehydes. Synthesis of Ibuprofen by BHC and BOOTS approach. Diels- Alder reaction, Leuckarts reductive amination of lactones. Oxidation of alcohols and sulphides. Supramolecules.

[16 Hours]

Books Recommended:

1. Photochemistry, R. B. Cundal and A. Gilbert, Thomas Nelson and Sons Ltd. London, 1st edn. (1970).
2. Organic Photochemistry, J. M. Coxon and B. Halton, Cambridge Univ. Press, London 1st edn. (1974).
3. Molecular reaction and Photochemistry, C. H. Depuy and O. S. Chapman, Prentice Hall, India, New Delhi, 1st edn. (1972).
4. Orbital Symmetry, R. E. Lehr and A. P. Marchand, Academic Press, New York, 1st edn. (1972).
5. Molecular Orbital theory for Organic Chemistry, A. Sreitweiser. Wiley and Sons, New York, 1st edn. (1961).

SCP 4.2: Spectrophotometric Analysis and Polarimetry

[64 Hours]

Spectrophotometry: Quantitative estimation of ascorbic acid, cholesterol, carbohydrates, proteins, aminoacids, caffeine and uric acid.

Polarimetry: Quantitative estimation of sugars, mixture of sugars and determination of specific rotation of sugars.

Books Recommended:

1. Applications of computers in chemistry- Raman.
2. Computers and their applications to chemistry- Ramesh Kumar, Narosa Publishing House (2002).
3. Laboratory experiments in organic chemistry – Arun Sethi, New Age International ltd. New Delhi (2006).
4. A Hand book of Organic chemistry – H. T. Clarke.
5. Vogel's text book of practical organic chemistry, revised 5th edn, Addison Wesley, Longman Ltd, UK (1997).

HCMP 4.3: Major Project

The project work may include inplant training in industries/short term work in the department/ other department or institution/ R & D organization/ review of current literature/ theoretical method computer applications/ experimental work may involve studies on synthesis of novel and known organic compounds, metal complexes and their characterization by physical and chemical methods/ drug analysis/ Biological activity of reported or unreported research work/ water, air and soil analysis/ pollution studies/ estimation of food adulterants.

In case of students working outside the campus the supervisor/ staff member incharge visit the place of work during the period and may be eligible for TA and DA as per university rules.

Books Recommended:

1. Applications of computers in chemistry- Raman.
2. Computers and their applications to chemistry- Ramesh Kumar, Narosa Publishing House (2002).
3. Laboratory experiments in organic chemistry – Arun Sethi, New Age International ltd. New Delhi (2006).
4. A Hand book of Organic chemistry – H. T. Clarke.
5. Vogel's text book of practical organic chemistry, revised 5th edn. Addison Wesley, Longman Ltd, UK (1997).