SACRED HEART COLLEGE (AUTONOMOUS)

Department of Physics

MASTER OF SCIENCE IN PHYSICS WITH ELECTRONICS

Course plan

Academic Year 2018-19

Semester One

Programme outcomes for the Postgraduate Students of Sacred Heart College, Kochi at the end of the programme,

PO 1	The students are capable of exercising their critical thinking in creating new knowledge leading to innovation, entrepreneurship and employability.
PO 2	The students are able to effectively communicate the knowledge of their study and research in their respective disciplines to their employers and to the society at large.
PO 3	The students are able to make choices based on the values upheld by the college, and have the readiness and know-how to preserve environment and work towards sustainable growth and development.
PO 4	The students possess an ethical view of life, and have a broader (global) perspective transcending the provincial outlook.
PO 5	The students possess a passion for exploring new knowledge independently for the development of the nation and the world and are able to engage in a lifelong learning process.

Programme Specific Outcomes of MSc Physics

At the end of M.Sc. Physics Programme, the student should be able to:

PROGRAM SPECIFIC OUTCOMES	
PSO 1	Develop the skills of critical analysis and problem-solving required in the application of principles of Physics.
PSO 2	Acquire a working knowledge of experimental and computational techniques and instrumentation required to work independently in research or industrial environments.
PSO 3	Demonstrate a strong capability of organizing and presenting acquired knowledge both in oral and written platforms.
PSO 4	Compete for current employment opportunities successfully.

Course Structure

Course Code	Title Of The Course	No. Hrs./Week	Credits	Total Hrs./Sem
16P1PHYT01	MATHEMATICAL METHODS IN PHYSICS – I	4	4	72
16P1PHYT02	CLASSICAL MECHANICS	4	4	72
16P1PHYT03	ELECTRODYNAMICS	4	4	72
16P1PHYT04	ELECTRONICS	3	3	54

Course I

COURSE PLAN

PROGRAMME	MASTERS OF PHYSICS	SEMESTER	1
COURSE CODE AND TITLE	16P1PHYT01: MATHEMATICAL METHODS IN PHYSICS – I	CREDIT	4
Theory HOURS/WEEK	4	HOURS/SEM	72
FACULTY NAME	Prof. ALEX SHINU SCARIA		

	COURSE OUTCOMES	PO/ PSO	CL
CO 1	Understand the concepts of different mathematical methods in physics	PO1, PSO1,PS03	U/A
CO 2	Apply to solve different physical problems.	PO1, PSO1, PSO2, PSO4	U/An

CL* Cognitive Level

SESSION	TOPIC	LEARNING RESOURCES	COURSE OUTCOME
	MODULE I		
1 & 2	Integral forms of gradient, divergence and curl, Line, surface and volume integrals	Lect + discussion	CO1
3 & 4	Stoke’s, Gauss’s and Green’s theorems	Lect + discussion	CO1, CO2
5 & 6	Potential theory - scalar, gravitational and centrifugal potentials	Lect	CO1
7 & 8	Orthogonal curvilinear coordinates	Lect + discussion	CO1, CO2
9 & 10	gradient, divergence and curl in Cartesian	Lect + discussion	CO1, CO2
11 & 12	gradient, divergence and curl in spherical and cylindrical co-ordinates	Lect	CO1
13 & 14	Equation of continuity - Linear vector spaces	Lect	CO1, CO2
15	Hermitian, unitary and projection operators with their properties	discussion	CO1, CO2
16, 17	inner product space - Schmidt orthogonalization	Lect	CO1
18	Hilbert space - Schwartz inequality	Lect+ Group Activity	CO1, CO2
	MODULE II		
19	Direct sum and direct product of matrices	Lect	CO1
20	diagonal matrices	Lect	CO1
21	Matrix inversion (GaussJordan inversion method)	Group discussion	CO2
22	orthoganal, unitary and Hermitian matrices, normal matrices	Lect	CO2
23	Pauli spin matrices	Lect	CO2
24	Cayley-Hamilton theorem	Group discussion	CO2
25 & 26	Similarity transformation - unitary and orthogonal	Lect	CO2

	transformation		
27	Eigen values and eigenvectors	Group discussion	CO2
28	Diagonalisation using normalized eigenvectors	Lect	CO2
29 & 30	Solution of linear equation-Gauss elimination method	Lect + discussion	CO2
31	Normal modes of vibrations.	Lect	CO2
32 & 33	Elementary probability theory, Random variables	Lect +Group discussion	CO2
34 & 35	Binomial, Poisson and Gaussian distributions	Lect + discussion	CO2
36	central limit theorem.	Lect	CO2
	MODULE III		
37 & 38	Definition of tensors, basic properties of tensors	Lect	CO1
39	Covariant, contravariant and mixed tensors	Lect + discussion	CO1
40	Levi-Civita tensor	Lect + discussion	CO 1
41 & 42	Metric tensor and its properties	Lect + discussion	CO 1
43 & 44	Tensor algebra	Lect + discussion	CO1, CO2
45 & 46	Christoffel symbols and their transformation laws	Lect + discussion	CO 1
47	covariant differentiation	Lect + discussion	CO 1
48	geodesic equation	Lect.	CO 1
49 & 50	Riemann-Christoffel tensor	Lect	CO 1
51 & 52	Ricci tensor and Ricci scalar.	Lect	CO 1
	MODULE IV		
53	Gamma and Beta functions	seminar + discussion	CO 2
54, 55 & 56	different forms of beta and gamma functions, evaluation of standard integrals	seminar + discussion	CO 2
57 & 58	Dirac delta function	seminar + discussion	CO 2
59 & 60	Kronecker Delta - properties and applications	seminar + discussion	CO 2
61 & 62	Bessel’s differential equation – Bessel and Neumann functions	seminar + discussion	CO 2
63 & 64	Legendre differential equation - Associated Legendre functions	seminar + discussion	CO 2
65 & 66	Hermite differential equation	Lect + discussion	CO 2
67 & 68	Laguerre differential equation	Lect + discussion	CO 2
69 & 70	Associated Laguerre polynomials. (Generating function, recurrence relations, and orthogonality condition for all functions)	Lect + discussion	CO 2
71	Rodrigue’s formula	Lect + discussion	CO 2
72	Problems	Group Activity	CO 2

INDIVIDUAL ASSIGNMENTS/SEMINAR – Details & Guidelines

	Date of completion	Topic of Assignment & Nature of assignment (Individual/Group – Written/Presentation – Graded or Non-graded etc)	Course Outcome
1	Before 1st Internal	Individual- Graded – 3 sets	CO1,CO2
2	Before 2nd Internal	Individual- Graded -3 sets	CO1, CO2

ASSIGNMENTS– Details & Guidelines – Will be notified prior to the announcement of the assignment – marks will be scaled to 5.

SEMINARS will be given to each student (20 mins duration) – 5 marks (CO1, CO2)

Basic Reference:

1) Mathematical Methods for Physicists, G.B. Arfken &H.J. Weber 4th Edition, Academic Press.
2) Mathematical Physics, P.K Chattopadhyay, New Age International (chapter 7)
3) Theory and problems of vector analysis, Murray R. Spiegel (Schaum's outline series)
4) Mathematical methods for Physics and Engineering, K.F. Riley, M.P Hobson, S. J. Bence, Cambridge University Press (Chapter 24)
5) Introduction to Mathematical Physics, Charlie Harper, PHI
6) Vector analysis and tensors, Schaum's outline series, M.R. Spiegel, Seymour Lipschutz, Dennis Spellman, McGraw Hill
7) Mathematical Physics, B.S. Rajput, Y. Prakash 9th Ed, Pragati Prakashan (Chapter 10)

8) Tensor Calculus: Theory and problems, A. N. Srivastava, Universities Press

Reference Books:

1. Mathematical Physics, B.D. Gupta, Vikas Pub.House, New Delhi

2. Advanced Engineering Mathematics, E. Kreyszig, 7th Ed., John Wiley

3. Introduction to mathematical methods in physics, G.Fletcher, Tata McGraw Hill

4. Advanced engineering mathematics, C.R. Wylie, & L C Barrett, Tata McGraw Hill

5. Advanced Mathematics for Engineering and Physics, L.A. Pipes & L.R. Harvill, Tata McGraw Hill

6. Mathematical Methods in Physics, J. Mathew & R.L. Walker, India Book House.

7. Mathematical Physics, H.K. Dass, S. Chand & Co. New Delhi.

Course II

COURSE PLAN

PROGRAMME	MASTERS OF PHYSICS	SEMESTER	1
COURSE CODE AND TITLE	16P1PHYT02: Classical Mechanics	CREDIT	4
Theory HOURS/WEEK	4	HOURS/SEM	72
FACULTY NAME	NAVYA S L		

	COURSE OUTCOMES	**PO/ PSO**	**CL**
CO 1	Understand the concepts of thermodynamics and probability.	PO1, PSO1,PS03	U/A
CO 2	Apply to the problems related to classical mechanics & thermodynamics using statistical mechanics	PO1, PSO1, PSO2, PSO4	U/An

CL* Cognitive Level

SESSION	**TOPIC**	**LEARNING RESOURCES**	**COURSE OUTCOME**
	MODULE I		
1 & 2	Review of Newtonian and Lagrangian formalisms -	Lect	CO1
3 & 4	cyclic co-ordinates – conservation theorems and symmetry properties	Lect	CO1
5 & 6	velocity dependent potentials and dissipation function	Lect	CO1
7	Hamilton's equations of motion	Lect	CO1
8 & 9	Least action principle – physical significance	Lect+ discussion	CO1
10	Problems	Lect+ discussion	CO1
11	Hamilton's principle	Lect	CO1
12 & 13	calculus of variations	Lect	CO1
14 & 15	examples	Lect + discussion	CO1
16	Lagrange's equations from Hamilton's principle	Lect	CO1
	MODULE II		
17	Stable and unstable equilibrium	Lect+ discussion	CO1
18	two-coupled oscillators	Lect	CO2
19 & 20	Lagrange's equations of motion for small oscillations – normal co-ordinates and normal modes	Lect+ discussion	CO2
21	oscillations of linear tri-atomic molecules	Lect+ discussion	CO2
22	Problems	Lect+ discussion	CO2
23	Equations of canonical transformation	Lect	CO2
24 & 25	examples of canonical transformation –	Lect	CO2

	harmonic oscillator		
26	Poisson brackets - properties	Lect	CO2
27	equations of motion in Poisson bracket form – angular momentum Poisson brackets	Lect	CO2
28	invariance under canonical transformations – Lagrange brackets	Lect	CO2
29	Problems	Lect+ discussion	CO2
30	Hamilton-Jacobi equation for Hamilton's principal function	Lect	CO2
31	harmonic oscillator problem	Lect + discussion	CO2
32 & 33	Hamilton - Jacobi equation for Hamilton's characteristic function	Lect	CO2
34	action angle variables in systems of one degree of freedom	Lect	CO2
35	Hamilton-Jacobi equation as the short wavelength limit of Schroedinger equation	Lect	CO2
36	problems	Lect + discussion	CO2
	MODULE III		
37	Reduction to the equivalent one body problem	Lect + discussion	CO 2
38 & 39	equations of motion and first integrals	Lect + discussion	CO 2
40 & 41	equivalent one-dimensional problem and classification of orbits	Lect + discussion	CO 2
42	differential equation for the orbits	Lect + discussion	CO 2
43	virial theorem	Lect + discussion	CO 2
44	Kepler problem	Lect + discussion	CO 2
45	Problems	Lect + discussion	CO 2
46	Angular momentum - kinetic energy	Lect + discussion	CO 2
47 & 48	inertia tensor - principal axes	Lect.	CO 2
49	Euler's angles	Lect	CO 2
50	infinitesimal rotations	Lect	CO 2
51	rate of change of a vector - Coriolis force	Lect	CO 2
52 & 53	Euler's equations of motion of a symmetric top	Lect	CO 2
54 & 55	heavy symmetric top with one point fixed	Lect + discussion	CO 2
56	problems	Lect + discussion	CO 2
	MODULE IV		
57	Principle of equivalence - principle of general covariance	PPT+SEMINAR+class activity	CO 2
58 & 59	motion of a mass point in a gravitational field – the Newtonian approximation – time dilation	PPT+SEMINAR+class activity	CO 2
60 & 61	rates of clocks in a gravitational field - shift in the spectral lines	PPT+SEMINAR+class activity	CO 2
62 & 63	energy- momentum tensor- Einstein's field equations	PPT+SEMINAR+class activity	CO 2
64	Poisson approximation - problems	PPT+SEMINAR+class	CO 2

		activity	
65	Linear and non-linear systems	PPT+SEMINAR+class activity	CO 2
66	integration of linear equation: Quadrature method	PPT+SEMINAR+class activity	CO 2
67	the pendulum equation	PPT+SEMINAR+class activity	CO 2
68 & 69	phase plane analysis of dynamical systems – phase curve of simple harmonic oscillator and damped oscillator.	PPT+SEMINAR+class activity	CO 2
70	phase portrait of the pendulum - bifurcation	PPT+SEMINAR+class activity	CO 2
71	logistic map – attractors - universality of chaos	PPT+SEMINAR+class activity	CO 2
72	Lyapunov exponent - fractals - fractal dimensions -Problems	PPT+SEMINAR+class activity	CO 2

INDIVIDUAL ASSIGNMENTS/SEMINAR – Details & Guidelines

	Date of completion	Topic of Assignment & Nature of assignment (Individual/Group – Written/Presentation – Graded or Non-graded etc)	Course Outcome
1	Before 1st Internal	Individual- Graded – 3 sets	CO1,CO2
2	Before 2nd Internal	Individual- Graded -3 sets	CO1, CO2

ASSIGNMENTS– Details & Guidelines – Will be notified prior to the announcement of the assignment – marks will be scaled to 5.

SEMINARS will be given to each student (20 mins duration) – 5 marks (CO1, CO2)

Basic Reference:

1. Classical Mechanics, H. Goldstein, C.P. Poole & J.L. Safko, Pearson, 3rd Ed.

2. Classical Mechanics, S.L. Gupta, V. Kumar & H.V. Sharma, Pragati Prakashan, 2007

3. Classical Mechanics, J.C. Upadhyaya, Himalaya, 2010

4. Classical Mechanics, G. Aruldhas, Prentice Hall 2009

5. Relativistic Mechanics, Satya Prakash, Pragathi prakashan Pub

6. Deterministic Chaos, N Kumar, University Press

Reference Books:

1. Classical Mechanics, N.C. Rana and P.S. Joag, Tata Mc Graw Hill

2. Introduction to Classical Mechanics, R.G. Takwale and P.S. Puranik, TMGH.

3. Langrangian and Hamiltonian Mechanics, M.G. Calkin, World Scientific Pub.Co Ltd
4. Introduction to General Relativity, R. Adler, M. Bazin, M. Schiffer, TMGH.
5. An introduction to general relativity, S. K. Bose, Wiley Eastern.
6. The Theory of Relativity, R.K. Pathria, Dover Pub. Inc. NY,2003
7. Chaos in Classical and Quantum Mechanics, M.C.Gutzwiller, Springer, 1990.
8. Classical Mechanics, G. Aruldhas, Prentice Hall 2009
9. Chaotic Dynamics, G.L.Baker & J.P.Gollub, Cambridge Uni. Press, 1996
10. Mathematical Methods for Physicists, G.B. Arfken &H.J. Weber 4th Edition

Course III

COURSE PLAN

PROGRAMME	MASTER OF SCIENCE (PHYSICS)	SEMESTER	1
COURSE CODE AND TITLE	16P1PHYT03: ELECTRODYNAMICS	CREDIT	4
HOURS/WEEK	4	HOURS/SEM	72
FACULTY NAME	MATHEW GEORGE		

CL* Cognitive Level

	COURSE OUTCOMES	**PO/ PSO**	**CL**
CO 1	To understand the concepts of electrodynamics and Maxwell equations	PO1,PO2, PSO1, PSO3, PSO4	Ap
CO 2	Apply Maxwell's Equations in Various situations	PO1,PO2,PSO1, PSO3, PSO4	An
CO3	To understand concepts of relativity	PO1,PO2,PSO1, PSO3, PSO4	Ap

Sessions	Topic	Method	Outcome
	Unit-1 Electrostatic fields in matter and Electrodynamics		
4	Review of Electrostatics and Magnetostatics,	lecture/discussion	CO1
1	Time varying fields and Maxwell's equations,	lecture/discussion	CO1, CO 2
1	Potential formulations, Gauge transformations, boundary conditions,	lecture/discussion	CO1
1	wave equations and their solutions,	lecture/discussion	CO1, CO 2
1	Poynting theorem,	lecture/discussion	CO1
2	Maxwell's stress tensor.	lecture/discussion	CO1, CO 2
1	Maxwell's equations in phasor notation. Plane waves in conducting and non-conducting medium,	lecture/discussion	CO1, CO 2
3	Polarization,	lecture/discussion	CO1
2	Reflection and transmission (Normal and Oblique incidence),	lecture/discussion	CO1, CO 2
2	Dispersion in Dielectrics, Superposition of waves, Group velocity.	lecture/discussion	CO1, CO 2
	Unit-2 Relativistic Electrodynamics		
2	Structure of space time:	lecture/discussion	CO3
2	Four vectors, Proper time and proper velocity,	lecture/discussion	CO3
1	Relativistic dynamics - Minkowiski force,	lecture/discussion	CO3
2	Magnetism as a relativistic phenomenon,	lecture/discussion	CO3
2	Lorentz transformation of electromagnetic field,	lecture/discussion	CO3
3	electromagnetic field tensor,	lecture/discussion	CO1,CO3
3	electrodynamics in tensor notation,	lecture/discussion	CO1,CO3
3	Potential formulation of relativistic electrodynamics.	lecture/discussion	CO1,CO3
	Unit-3 EM Radiation		
2	Retarded potentials,	lecture/discussion	CO1
2	Jefimenkos equations,	lecture/discussion	CO1

3	Point charges, Lienard-Wiechert potential,	lecture/discussion	CO1
2	Fields of a moving point charge,	lecture/discussion	CO1
3	Electric dipole radiation,	lecture/discussion	CO1
2	Magnetic dipole radiation,	lecture/discussion	CO1
2	Power radiated by point charge in motion.	lecture/discussion	CO1
2	Radiation reaction,	lecture/discussion	CO1
2	Physical basis of radiation reaction.	lecture/discussion	CO1
	Unit-4 Antenna, Wave Guides and Transmission Lines		
1	Radiation resistance of a short dipole,	lecture/discussion	CO1
2	Radiation from quarter wave monopole or half wave dipole.	lecture/discussion	CO1
3	Antenna parameters.	lecture/discussion	CO1
2	Waves between parallel conducting plane TE, TM and TEM waves,	lecture/discussion	CO1, CO 2
2	TE and TM waves in Rectangular wave guides,	lecture/discussion	CO1, CO 2
1	Impossibility of TEM waves in rectangular wave guides.	lecture/discussion	CO1, CO 2
3	Transmission Lines-Principles-Characteristic impedance,	lecture/discussion	CO1
2	standing waves-quarter and half wavelength lines	lecture/discussion	CO1

INDIVIDUAL ASSIGNMENTS/SEMINAR – Details & Guidelines

		Seminars	Couse Outcome
1		Topic, to be given later	CO1

Assignments/seminars: In addition to lectures students will have to submit assignments given, to strengthen their mastery in the subject. There will also be one seminar, to be given by the students

References:

1. Introduction to Electrodynamics, Griffiths

2. Electromagnetic Waves and Radiating Systems, Balmain and Jordan.

3. Other books specified in the syllabus.

Course IV

COURSE PLAN

PROGRAMME	MASTERS OF PHYSICS	SEMESTER	1
COURSE CODE AND TITLE	16P1PHYT04 - ELECTRONICS	CREDIT	3
Theory HOURS/WEEK	3	HOURS/SEM	54
FACULTY NAME	Dr. Sumod SG		

	COURSE OUTCOMES	**PO/ PSO**	**CL**
CO 1	Understand the theoretical aspects of OP-amps	PO1, PSO1,PS03	U/A
CO 2	Apply the OP-amp circuits for various practical applications	PO1, PSO1, PSO2, PSO4	U/An

CL* Cognitive Level

SESSION	**TOPIC**	**LEARNING RESOURCES**	**COURSE OUTCOME**
	MODULE I		
1	Introduction Differential amplifier – Inverting amplifier – Non-inverting amplifier -	Lect	CO1
2	Block diagram representations – Voltage series feedback:	Lect	CO1
3	Negative feedback –	Lect	CO1
4	closed loop voltage gain – Difference input voltage ideally zero	Lect	CO1
5	– Input and output resistance with feedback –	Lect	CO1
6	Bandwidth with feedback – Total output offset voltage with feedback –.	Lect	CO1
7	Voltage follower. Voltage shunt feedback amplifier:	Lect	CO1
8	Closed loop voltage gain – inverting input terminal and virtual ground -	Lect	CO1

9	input and output resistance with feedback – Bandwidth with feedback -	Lect	CO1
10	Total output offset voltage with feedback –	Lect	CO1
11	Current to voltage converter-	Lect+ Group Activity	CO1
12	Inverter. Differential amplifier with one op-amp	Lect	
13	Differential amplifier two op-amps	Lect	
MODULE II			
14	Input offset voltage –Input bias current –	Lect	CO2
15	input offset current –	Lect	CO2
16	Problems	Lect	CO2
15	Total output offset voltage- Thermal drift –	Lect	CO2
17	Effect of variation in power supply voltage on offset voltage –	Lect	CO2
18	Change in input offset voltage and input offset current with time - Noise –	Lect	CO2
19	Common mode configuration and CMRR.	Lect	CO2
20	DC and AC amplifiers	Lect	CO2
21	– AC amplifier with single supply voltage	Lect	CO2
22	– Peaking amplifier – Summing	Lect	CO2
23	Scaling, averaging amplifiers –	Lect	CO2
24	Instrumentation amplifier using transducer bridge –	Lect	CO2
25	Differential input and differential output amplifier –	Lect	CO2
26	Low voltage DC and AC voltmeter -	Lect	CO2
27	Voltage to current converter with grounded load –	Lect	CO2
28	Current to voltage converter –	Lect	CO2
29	Very high input impedance circuit –	PPT+SEMINAR+class activity	CO2
30	Integrator	PPT+SEMINAR+class activity	CO2
31	Differntiator	PPT+SEMINAR+class activity	CO2
MODULE III			
32	Frequency response –	Group Activity	CO 3
33	Compensating networks –	PPT+SEMINAR+class activity	CO 3
34	Frequency response of internally compensated and non compensated op-amps –	PPT+SEMINAR+class activity	CO 3
35	High frequency op-amp equivalent circuit –	PPT+SEMINAR+class activity	CO 3
36	Open loop gain as a function of frequency	PPT+SEMINAR+class activity	CO 3
37	– Closed loop frequency response – Circuit stability - slew rate..	Lect.	CO 3

38	Active filters –	Lect	CO 3
39	First order LPBWF	Lect	CO 3
40	second order low pass Butterworth filter	Lect	CO 3
41	- First order HPBWF	Lect	CO 3
42	and second order high pass Butterworth filter-	PPT+SEMINAR+class activity	CO 3
43	wide band pass filter	PPT+SEMINAR+class activity	CO 3
44	narrow band pass filter - wide and	PPT+SEMINAR+class activity	CO 3
45	narrow band reject filter- All pass filter –	Group Activity	CO 3
46	Oscillators: Phase shift and Wien-bridge oscillators –	PPT+SEMINAR+class activity	CO 3
47	square, triangular and	PPT+SEMINAR+class activity	CO 3
48	sawtooth wave generators- Voltage controlled oscillator	PPT+SEMINAR+class activity	CO 3
49	Problems	PPT+SEMINAR+class activity	CO 3
50	Basic comparator- Zero crossing detector- Schmitt Trigger –	Lect.	CO 3
51	Comparator characteristics- Limitations of op-amp as comparators-	Lect	CO 3
52	Peak detector– Sample and Hold circuit	Lect	CO 3
53	Problems	Lect	CO 3
54	Revision	Lect	CO 3

INDIVIDUAL ASSIGNMENTS/SEMINAR – Details & Guidelines

	Date of completion	Topic of Assignment & Nature of assignment (Individual/Group – Written/Presentation – Graded or Non-graded etc)	Course Outcome
1	Before 1st Internal	Individual- Graded – 3 sets	CO1,CO2
2	Before 2nd Internal	Individual- Graded -3 sets	CO3, CO4

ASSIGNMENTS– Details & Guidelines – Will be notified prior to the announcement of the assignment – marks will be scaled to 5.

SEMINARS will be given to each student (20 mins duration) – 5 marks (CO3, CO4)

Basic Reference:

1. Op-amps and linear integrated circuits R.A. Gayakwad 4th Edn. PHI.

Reference Books:

1. Electronic Devices (Electron Flow Version), 9/E Thomas L. Floyd, Pearson

2. Fundamentals of Electronic Devices and Circuits 5th Ed. David A. Bell, Cambridge.

3. Linear Integrated Circuits and Op Amps, S Bali, TMH