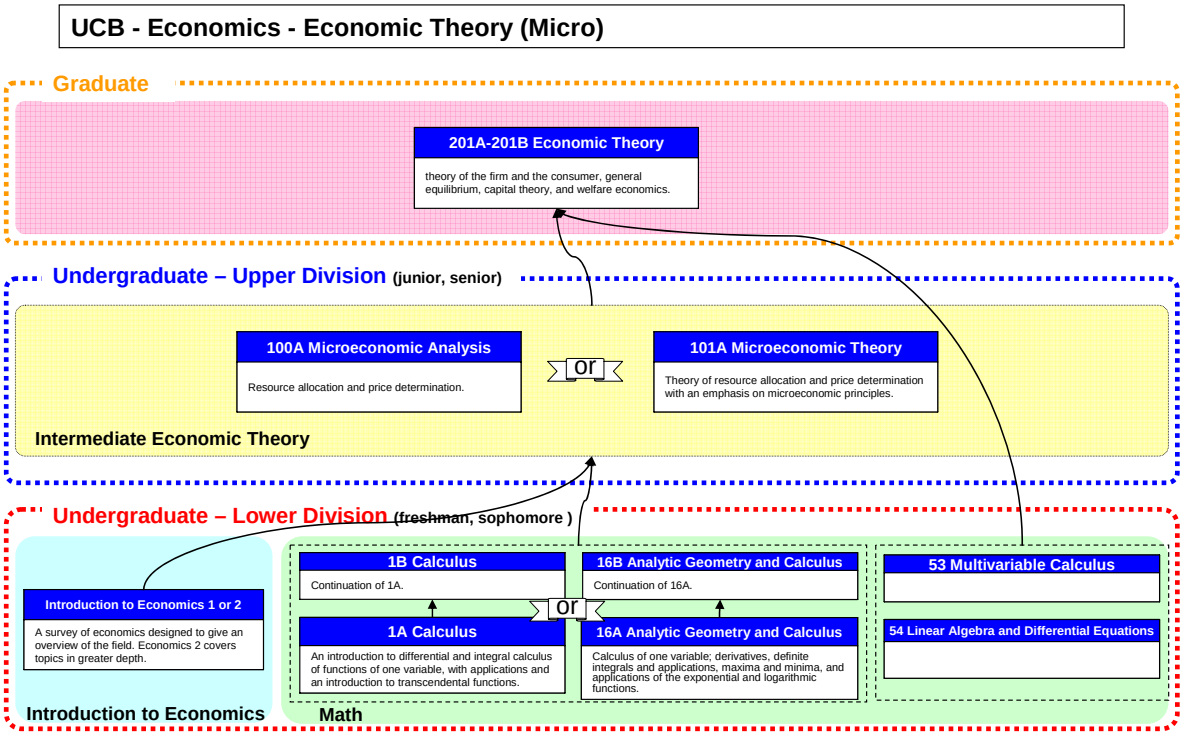
C.　各分野のカリキュラム比較

C.1 物理学

C.1.1　カリフォルニア大学バークレー校



UC Berkeley – Economics
Undergraduate

Division	Year	Courses	区分	Requirement
Lower Division (freshman, sophomore)		Mathematics 1A–1B. Calculus	Math	○
		Mathematics 16A–16B. Analytic Geometry and Calculus		
		Statistics 20, 21, 25 or any upper division statistics course	Statistics	○
		1. Introduction to Economics	Introduction to Economics	○
		2. Introduction to Economics—Lecture Format		
		C3. Introduction to Environmental Economics and Policy	（区分不明）	
	Freshman	24. Freshman Seminar		
	Sophomore	84. Sophomore Seminar		
	Freshman	90. Freshman Seminar		
		98. Directed Group Study		
Upper Division (junior, senior)		100A. Economic Analysis—Micro	Economic Theory	○ （100A–Bまたは101A–B）
		100B. Economic Analysis—Macro		
		101A. Economic Theory—Micro		
		101B. Economic Theory—Macro		
		C103. Introduction to Mathematical Economics		
		104. Advanced Microeconomic Theory		
		C110. Game Theory in the Social Sciences		
		140. Econometric Theory and Statistics	Econometric	○
		141. Economic Statistics and Econometrics		
		105. History of Economic Thought	Economic Histroy and History of Economic Thought	
		113. American Economic History		
		114. American Economic History Seminar		
		115. The World Economy in the Twentieth Century.		
		C102. Natural Resource Economics	Applications and Institutions	
		119. Psychology and Economics		
		121. Industrial Organization and Public Policy		
		122. Industrial Organization Seminar		
		123. Government Regulation		
		124. Special Topics in Industrial Organization. (3)		
		125. Economics of the Environment		
		126. Industrial Organization: Theory and Evidence		
		131. Public Sector Microeconomics		
		132. Seminar in Public Sector Economics		
		136. Financial Economics		
		137. Aggregate Economics Seminar		
		C142. Applied Econometrics and Public Policy		
		151. Labor Economics		
		152. Wage Theory and Policy		
		153. Labor Economics Seminar		
		157. Health Economics		
		161. Economics of Transition: Eastern Europe		
		162. Economics of Transition and Development: China		
		C171. Economic Development		
		172. Case Studies in Economic Development		
		173. Economic Development Seminar		
		C175. Economic Demography		
		181. International Trade		
		182. International Monetary Economics		
		183. International Economic Seminar		
		190. Seminar on Topics in Economics		
		163. Special Topics in Economic Systems	（区分不明）	
	Senior	H195A–B. Senior Honors Thesis		
		197. Field Studies		
		198. Directed Group Study		
		199. Supervised Independent Study and Research		

○：選択必修

（注）
・学位取得要件として、必修科目の他に、Upper Divisionの5コースの履修が必要である。
・Lower Divisionのコースには、全学部の学生を対象としたものも含まれる。

UC Berkeley – Economics
Graduate(Ph.D)

Year	Courses	区分	Requirement
Year 1	201A–201B. Economic Theory	Economic Theory	◎
	202A–202B. Macroeconomic Theory		◎
	204. Mathematical Tools for Economics	Math	◎
	210A. Introduction to Economic History	Economic History	◎
	240A. Introductory Statistics and Econometrics	Econometrics	◎
	240B. Introduction to Statistics and Econometrics		◎
	203. Advanced Topics in Economic Theory		
	206. Mechanism Design and Agency Theory		
	207A–207B. Mathematical Economics		
	208. Microeconomic Theory Seminar		
	209A. Theory and Application of Non–Cooperative Games		
	209B. Theory and Application of Non–Cooperative Games: II.		
	210B. Topics in European Economic History		
	210C. Topics in American Economic History		
	211. Seminar in Economic History		
	215A–215B. Political Economics		
	215C. Selected Topics in Political Economy		
	218. Seminar in Psychology and Economics		
	219A. Foundations of Psychology and Economics		
	219B. Applications of Psychology and Economics		
	219C. Topics in Psychology and Economics		
	219D. Experimental Economics		
	220A. Industrial Organization		
	220B. Industrial Organization		
	220C. Special Topics in Industrial Organization		
	221. Seminar in Industrial Organization: Regulation and Public Enterprise		
	222. Economics of Innovation		
	224. Economics of Institutions		
	225. Workshop in Institutional Analysis		
	230A. Public Sector Microeconomics		
	230B. Public Sector Microeconomics		
	C230C. Public Sector Microeconomics		
	231. Seminar in Public Sector Economics		
	236A–236B. Aggregate Economics		
	236C. Capital and Economic Growth		
	237. Seminar in Advanced Macroeconomics and Money		
	241A. Econometrics		
	241B. Econometrics		
	242. Seminar in Econometrics		
	243. Special Topics in Econometric Theory		
	244. Applied Econometrics		
	250A–250B. Labor Economics		
	250C. Labor Economics		
	251. Seminar in Labor Economics		
	260A–260B. Economics of Transition		
	261. Seminar in Comparative Economics		
	270A–270B. Analytics of Economic Development and Planning		
	C270A. Microeconomics of Development		
	270C. Analytics of Economic Development and Planning		
	270D. Special Topics in Development		
	271. Seminar in Economic Development and Planning		
	C275A. Economic Demography		
	C275B. Aging: Economic and Demographic Aspects		
	280A. International Economics		
	280B. International Economics		
	280C. International Economics		
	281. Seminar in International Trade and Finance		
	C287. Special Topics in Health Economics		
Year 3～	291. Departmental Seminar		◎
Year 1	295. Survey of Research in Economics		
	296. Special Topics in Economics		
	298. Directed Group Study for Graduates		
	299. Supervised Independent Study and Research		
	602. Individual Study for Doctoral Students		

◎:必修

（注）
・Ph.D programのみで、M.A. programはない。
・1年次には8つのコアコースが必修。
・2年次は、次の18分野から2分野を履修。

Advanced Economic Theory	Industrial Organization
Comparative Economics	International Economics
Development Economics	Labor Economics
Econometrics	Law and Economics
Economic Demography	Macroeconomics
Economic History	Mathematical Economics
Economics of Institutions	Political Economics
Finance	Psychology and Economics
Financial Economics	Public Finance

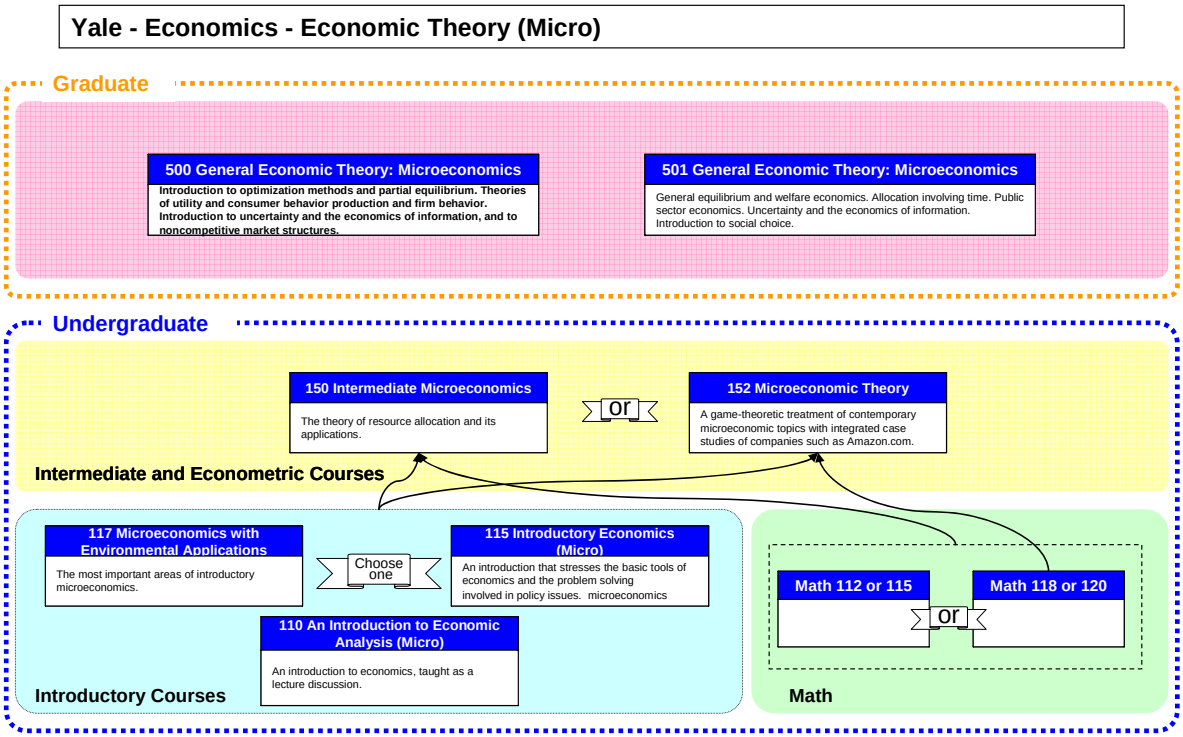
＊2分野のうち1分野は他departmentが提供する次の科目を選択することが可能（Graduate Committeeの承認が必要）。
Education and Economics, Health Economics, Resource Economics
Urban and Regional Economics or City and Regional Planning
・学位取得要件としてdissertationが必要である。

Structure of Subjects in Economics, Microeconomics (Examples)
UC Berkeley

◎必修、○選択必修

	Enrollment Period	Subjects	Requirement	Size of the Subject	Prerequisite subjects	Aim of Lecture	Contents of the Subject (Lecture Items)	Grading	Textbooks
				・ Credits ・ Number of lectures		・ Aim and Outline of the Lecture	・ Structure of Lecture (at the headline syllabus level) ・ Major lecture items (laws, formulae, units, etc.)		
Undergraduate	Lower division (freshman, sophomore)	**1. Introduction to Economics**	○	4 credits. Two hours of lecture and two hours of discussion per week.	None	A survey of economics designed to give an overview of the field.	See "LECTURE SCHEDULE".	Your course grade will be based on: Problem sets, 5%; First midterm, 25%; Second midterm, 25%; Final exam, 45%. Grading will be entirely separate for each GSI. It is expected that each GSI will give about 30% of his/her students A's of some kind, 35% B's of some kind, and the rest C's or below.	Principles of Economics, by Karl Case and Ray Fair, 8th or 7th edition. Either edition is fine.
		2. Introduction to Economics		4 credits. Three hours of lecture and one hour of discussion per week.	None	The course provides a survey of economics principles and methods. It covers both microeconomics, the study of consumer choice, firm behavior, and market interaction, and macroeconomics, the study of economic growth, unemployment, and inflation. Special emphasis is placed on the application of economic tools to contemporary economic problems and policies.	N/A	N/A	N/A
	Upper division (junior, senior)	**100A. Economic Analysis —Micro**	○ (100A-B or 101A-B)	4 credits. Three hours of lecture and two hours of discussion per week.	1 or 2 or C3, or Environmental Economics and Policy 1, and Math 1A or Math 16A	Resource allocation and price determination.	See "Syllabus".	Grades in the course will be determined according to this formula: 10% Lecture and section participation; pop quizzes (or approved research project), 10% Five graded problem sets (2 points per problem set), 20% Midterm 1, 25% Midterm 2, 35% Final Exam	Microeconomics, 6th Edition by Robert S. Pindyck and Daniel L. Rubinfeld
		100B. Economic Analysis —Macro		4 credits. Three hours of lecture and two hours of discussion per week.	1 or 2 or C3, or Environmental Economics and Policy 1, and Math 1A or Math 16A	A study of the factors which determine national income, employment, and price levels, with attention to the effects of monetary and fiscal policy.	（Macroのため、以降省略）		
		101A. Economic Theory—Micro		4 credits. Three hours of lecture and two hours of discussion per week.	1 or 2 or C3, or Political Economy of Natural Resources 1; Mathematics 1A-1B or equivalent.	Theory of resource allocation and price determination with an emphasis on microeconomic principles.	See "Syllabus".	30% 6 Problem Sets, 20% Midterm 1, 20% Midterm 2, 40% Final Exam The percentages above sum to 110%. The worst 10% of the score will not count toward your grades. For example, if the worst score is on the problem sets, the problem sets will only have 20% of weight. There is a second bonus. High-quality class participation can increase the score by at most one grade; for example, from B to B+.	Walter Nicholson, Microeconomic Theory – 9th Edition, Southwestern Editors
		101B. Economic Theory—Macro		4 credits. Three hours of lecture and two hours of discussion per week.	101A	A study of theories of the determination of national income, employment, and price levels, with attention to the effects of monetary and fiscal policy.	（Macroのため、以降省略）		
Graduate	Year 1	**201A Economic Theory**	◎	4 credit each. Three hours of lecture and two hours of discussion per week.	100A-100B or 101A-101B or equivalent. Mathematics 53 and 54 or equivalent.	Basic preparationfor the Ph.D. program including: theory of the firm and the consumer, general equilibrium, capital theory, and welfare economics.	See "Syllabus(1st half)".	The final numerical grade for 201A will be max{.5g1 + .5g2, .4g1 + .6g2} where g1and g2 are the respective grades in Parts 1 and 2. The grade for part 1 will be based 80% on the midterm exam and 20% on the problem sets. The final exam will cover the material of the second half of the course with material from the first half only to the extent it is needed in doing the work of the second half.	・Microeconomic Theory, A. Mas-Colell, M.D. Whinston and J.R. Green. (MWG) ・Mathematical Methods and Models for Economists, Angel de la Fuente. ・Microeconomic Analysis, Third Edition, H. Varian. (V)
		201B. Economic Theory	◎		Economics 204 (or equivalent), and Economics 201A.		1. Adverse Selection in Markets (Akerlof's model, Signaling, Screening) 2. Nonlinear Pricing (Two-type model, General techniques) 3. Cheap Talk 4. Moral Hazard (Basic principal-agent problem) 5. Career Concerns 6. Mechanism Design (Pivotal mechanisms, The revelation principle, Auction theory)	The final grade for 201B will be based on an unweighted average of the numerical scores in information economics and general equilibrium. Chris Shannon and I will consult on how to convert the numerical scores to letter grades.	"Contract Theory" by Patrick Bolton and Mathias Dewatripont, MIT Press, 2005. （ただし、required readingではない）

C.1.2　イェール大学


Yale - Economics - Economic Theory (Micro)
Graduate
500 General Economic Theory: Microeconomics
Introduction to optimization methods and partial equilibrium. Theories of utility and consumer behavior production and firm behavior. Introduction to uncertainty and the economics of information, and to noncompetitive market structures.
501 General Economic Theory: Microeconomics
General equilibrium and welfare economics. Allocation involving time. Public sector economics. Uncertainty and the economics of information. Introduction to social choice.
Undergraduate
150 Intermediate Microeconomics
The theory of resource allocation and its applications.
or
152 Microeconomic Theory
A game-theoretic treatment of contemporary microeconomic topics with integrated case studies of companies such as Amazon.com.
Intermediate and Econometric Courses
117 Microeconomics with Environmental Applications
The most important areas of introductory microeconomics.
Choose one
115 Introductory Economics (Micro)
An introduction that stresses the basic tools of economics and the problem solving involved in policy issues. microeconomics
110 An Introduction to Economic Analysis (Micro)
An introduction to economics, taught as a lecture discussion.
Introductory Courses
Math 112 or 115
or
Math 118 or 120
Math

Yale – Economics
Yale College (undergraduate course)

Year	Courses	授業形態	区分	Requirement	
	math 112a or b, Calculus of Functions of One Variable I		Math	○	
	math 115a or b, Calculus of Functions of One Variable II				
	math 118a or b, Introduction to Functions of Several Variables				
	math 120a or b, Calculus of Functions of Several Variables				
freshman	econ 110a, An Introduction to Economic Analysis (Micro) – freshmen only		Introductory courses	○	
	econ 115a or b, Introductory Economics (Micro)				
	econ 117a, Microeconomics with Environmental Applications				
freshman	econ 111b, An Introduction to Economic Analysis (Macro) – freshmen only			○	
	econ 116a or b, Introductory Economics (Macro)				
	econ 150a or b Intermediate Microeconomics		Theory, quantitative, and mathematical economics	○	
	econ 152a Microeconomic Theory			○	
	econ 153b, Macroeconomic Theory				
	econ 154a or b, Intermediate Macroeconomics			○	
	econ 161a or b, Econometrics and Data Analysis I				
	econ 163b, Econometrics				
	econ 155a, Mathematical Economics: General Equilibrium Theory				
	econ 156b, Mathematical Economics: Game Theory				
	econ 159a, Game Theory				
	econ 162a, Introduction to Probability and Statistics				
	econ 200b, Firms, Markets, and Competition		Market Organization		
	econ 225a or b, Labor Economics and Welfare Policies		Human resources		
	econ 251a, Financial Theory		Finance		
	econ 252b, Financial Markets				
	econ 275a, Public Economics		Public sector		
	econ 276b, Law and Economics				
	econ 280b/afam 282b, Poverty under Postindustrial Capitalism				
	econ 330a or b, Economics of Natural Resources				▲
	econ 182b/hist 135b, American Economic History		International and Development economics		
	econ 300a, International Trade Theory and Policy				
	econ 301b, International Monetary Theory and Policy				
	econ 325a/ints 352a, Economics of Developing Countries				
	econ 429a, Economic Development of Japan				▲
	econ 120a or b, Introduction to Chinese Economy		（区分不明）		
	econ 166b, Econometrics and Data Analysis II.				
	econ 170a, Health Economics and Public Policy				
	econ 187a, European Economic History, 1815-1945.				
	econ 329b/735b, Economics of Agriculture				▲
	econ 498a and 499b, Directed Reading				
	econ 450a, Investment Analysis	Departmental seminars	Finance	○ (2 seminars. At least one in senior year.)	
	econ 451a, The Theory and History of Money and Financial Institutions				
	econ 459a or b, Corporate Finance				
	econ 484b, The United States Banking System				
	econ 453a, Antitrust Law and Economics		Market Organization		
	econ 455b, Information Economy				
	econ 460b, World Trading System		International and Development economics		
	econ 463a/ep&e 437a, Economic Problems of Latin America				
	econ 466a, Topics in International Trade				
	econ 476a, Topics in International Economics.				
	econ 478a, Economics Development of India & South East Asia				
	econ 467a or b/ep&e 414a or b, Issues in Health Economics		Human resources		
	econ 480b, Topics in Macroeconomics		Theory, quantitative, and mathematical economics		
	econ 488a, Experimental Economics				
	econ 454b, Topics in Applied Game Theory				
	econ 456a or b, Private Equity Investing				
	econ 457b, A Historical & Institutional Appraisal of Modern Capital Markets				
	econ 468b, Institutions and Incentives in Economic Development				
	econ 470a/ep&e 413a, Topics in American Economic History.				
	econ 477a, Economics of Auctions		（区分不明）		
	econ 481a or b/ep&e 427a, Urban Economics				
	econ 483a The Economy, Elections and Markets				
	econ 485b, Behavioral Economics				
	econ 486a, Topics in Labor Economics				
	econ 489b/ep&e 441b, Topics in Economic Policy				
senior	econ 491a and 492b, The Senior Essay.				

◎：必修
○：選択必修
▲：大学院、学部共通

（注）
・学位取得要件として、必修科目も含め12コースの履修が必要である。

Yale – Economics
Graduate(Ph.D)

Year	Courses	区分	Requirement	
First	ECON 500a, General Economic Theory: Microeconomics	Economic Theory	★	
	ECON 501b, General Economic Theory: Microeconomics		★	
	ECON 510a, General Economic Theory: Macroeconomics		★	
	ECON 511b, General Economic Theory: Macroeconomics		★	
	ECON 520a, Advanced Microeconomic Theory I.			
	ECON 521b, Advanced Microeconomic Theory II.			
	ECON 522a & 523b,Topics in Game Theory.			
	ECON 524a, Behavioral Applied Theory			
	ECON 525a, Advanced Macroeconomics I.			
	ECON 526b, Advanced Macroeconomics II.			
	ECON 527a, Behavioral and Institutional Economics.			
	ECON 530a, Mathematical Economics I.			
	ECON 531a/b, Mathematical Economics II.			
	ECON 532au, General Equilibrium under Uncertainty.			
	ECON 533a and b,Workshop on Discrete Mathematics and Applications.			
	ECON 535a and b, Prospectus Workshop in Mathematical Economics.			
	ECON 537a and 538b, Microeconomic Theory Workshop.			
	ECON 54oa and 541b, Student Workshop in Macroeconomics.			
	ECON 542a and 543b, Macroeconomics Workshop.			
	ECON 544a, Economic Analysis.			
	ECON 545a, Microeconomics.			
	ECON 546b, Macroeconomics.			
First	ECON 550a, Econometrics I.	Econometrics	★	
	ECON 551b, Econometrics II.		★	
	ECON 552b, Econometrics III.			
	ECON 553a, Econometrics IV:Time Series Econometrics.			
	ECON 554b, Econometrics V.			
	ECON 555b, Applied Econometrics II: Microeconometrics.			
	ECON 557b,Time Series Econometrics II: Unit Roots and Co-Integration.			
	ECON 558a, Econometrics.			
	ECON 561a, Computational Method for Economic Dynamics.			
	ECON 567a and 568b, Econometrics Workshop.			
	ECON 570a and 571b, Prospectus Workshop in Econometrics.			
	ECON 580a, General Economic History: Western Europe.	Economic History		
	ECON 581b, American Economic History.			
	ECON 582b, General Economic History: Latin America.		★	
	ECON 583a,Topics in Economic History.			
	ECON 588a and 589b, Economic History Workshop.			
	ECON 600a, Industrial Organization I.	Market Organization and Public Policy		
	ECON 601b, Industrial Organization II.			
	ECON 606a and 6o7b, Prospectus Workshop in Microeconomics.			
	ECON 608a and 6o9b,Workshop in Applied Microeconomics.			
	ECON 630a, Labor Economics.	Labor Economics		
	ECON 631b, Labor Economics.			
	ECON 638a and 639b, Labor and Population Workshop.			
	ECON 670a, Financial Economics I.	Money and Finance		
	ECON 671b, Financial Economics II.			
	ECON 672a, Behavioral Finance.			
	ECON 680a, Public Finance I.	Economics of the Public Sector		
	ECON 681b, Public Finance II.			
	ECON 702b, International Economics.	International Trade and Finance		
	ECON 708b, International Economic Analysis.			
	ECON 709a, International Economics and Open Economy Macroeconomics.			
	ECON 720a, International Trade I.			
	ECON 721b, International Trade II.			
	ECON 724b, International Finance.			
	ECON 730a, Economic Development I.	Economic Development		
	ECON 731b, Economic Development II.			
	ECON 732b, Economic Development IDE.			
	ECON 735bu, Economics of Agriculture.			▲
	ECON 736au, Economics of Technology.			▲
	ECON 737bu, Economics of Natural Resources.			▲
	ECON 738a or b,Workshop on Environmental and Natural Resources.			
	ECON 749a and 750b,Trade and Development Workshop.			
	ECON 756a/b, Prospectus Workshop in Development.			
	ECON 776bu, Economics of Population.	Economic Demography		▲
	ECON 788a, Political Competition.	Economic Systems and National Economies		
	ECON 790b, Political Economy.			
	ECON 791a, Theories of Distributive Justice.			
	ECON 802au, Economic Development of Japan.			▲
	ECON 899a or b, Individual Reading and Research.			

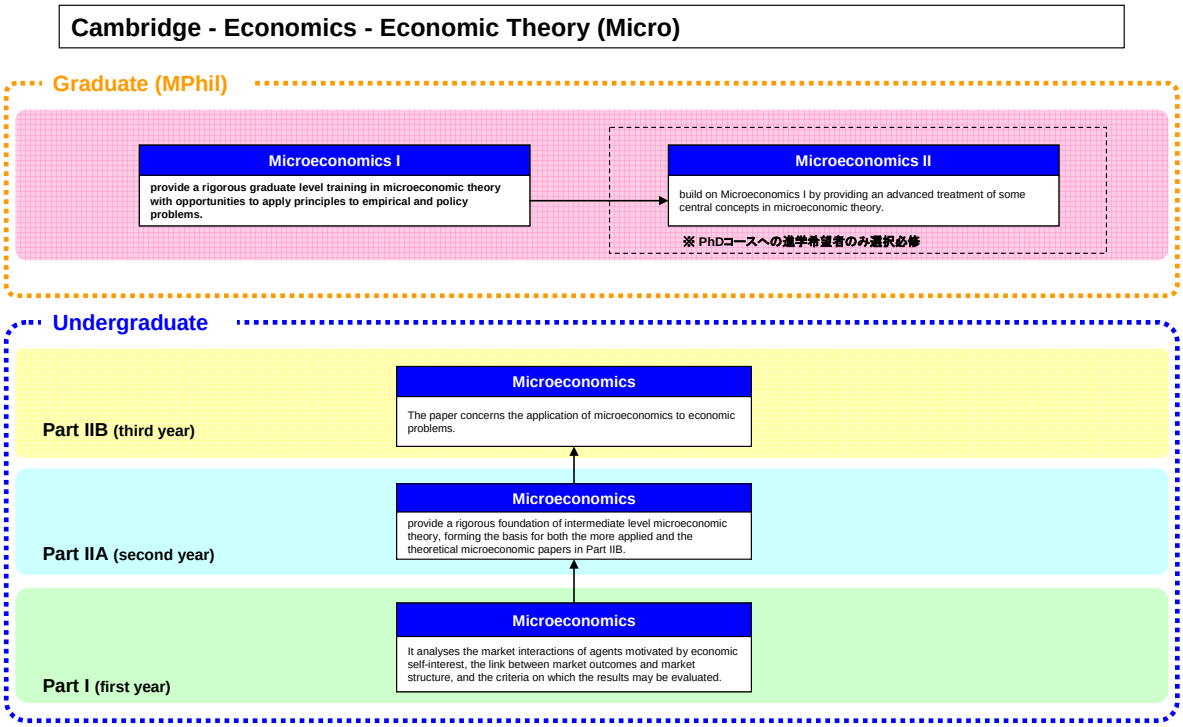
★:履修を推奨
▲:大学院、学部共通

(注)
・Ph.D programのみでM.A. programはない。
　→ただし、M.Phil degree、M.A. degree (en route to the Ph.D.)の取得は可能。
　　Economic Growth Centerでは、one year MA program (International and Development Economics)を提供している。
・Second Year、Third Yearの登録に際しての要件(取得済みコース数、成績等)あり。ただし、必修科目はなし。
・First Yearには、この他に、economics or related subjects, such as probability theory, mathematics, or financeの履修(1 course)が推奨されている。
・学位取得要件として、dissertationの提出が必要である。

Yale University
Structure of Subjects in Economics, Microeconomics

	Enrollment Period	Subjects	Requirement	Size of the Subject	Prerequisite subjects	Class Size	Aim of Lecture	Contents of the Subject (Lecture Items)	Grading	Textbooks
Undergraduate	freshman	**econ 110a An Introduction to Economic Analysis (Microeconomics)**	選択必修	3 hours of lecture per week	None	in a small-class format (thirty students per section)	An introduction to economics, taught as a lecture discussion.	N/A	N/A	N/A
	N/A	**econ 115a or b Introductory Economics (Microeconomics)**		1 course credit. 3 hours of lecture per week.	None	N/A	An introduction that stresses the basic tools of economics and the problem solving involved in policy issues.	N/A	N/A	N/A
	N/A	**econ 117a Microeconomics with Environmental Applications.**		1 course credit. 3 hours of lecture per week.	None	N/A	The most important areas of introductory microeconomics. Emphasis on topics most relevant to the study of the environment, including externalities, regulation, public goods, and consumer surplus analysis.	N/A	N/A	N/A
	N/A	**econ 150a or b, Intermediate Microeconomics**	選択必修	1 course credit. 3 hours of lecture per week.	two terms of introductory economics and completion of the mathematics requirement for the major or its equivalent.	N/A	The theory of resource allocation and its applications. Topics include the theory of consumer behavior, production, firm behavior, and price and wage determination in different market structures. Empirical applications explore strengths and limitations of the theoretical models.	N/A	N/A	N/A
	N/A	**econ 152a, Microeconomic Theory**		1 course credit. 3 hours of lecture per week.	two terms of introductory economics and Math 118a or b or 120a or b.	N/A	A game-theoretic treatment of contemporary microeconomic topics with integrated case studies of companies such as Amazon.com. Topics include consumer behavior, perfect competition, market efficiency, externalities, public goods, price discrimination, and insurance markets.	I. Introduction. II. Choice Under Certainty (5 lectures). Preferences and Utility (JR 1.2); The Consumer's Problem (JR 1.3); Indirect Utility and Expenditure Functions (JR 1.4); Properties of Consumer Demand (JR 1.5); Revealed Preference (JR 2.3). III. Choice Under Uncertainty (3 lectures). Objective Probability and Expected Utility (JR 2.4); Subjective Probability (JR 2.4); Risk Aversion (JR 2.4). IV. Theory of the Firm (2 lectures). Production Functions (JR 3.2); Cost Functions (JR 3.3); Profit Maximization (JR 3.5). V. Partial Equilibrium (1 lecture). Perfect Competition (JR 4.1); Equilibrium and Welfare (JR 4.3). VI. General Equilibrium (5 lectures). The Edgeworth Box Exchange Economy (JR 5.1); Exchange Economies (JR 5.2); The Efficiency of Competitive Equilibria (JR 5.2.2); General Equilibrium with Production (JR 5.3); The Core (JR 5.4). VII. Game Theory and Imperfect Competition (4 lectures). Monopoly; Game Theory: Static Games (JR 7.2); Game Theory: Dynamic Games (JR 7.3); Oligopoly (JR 4.2); Auctions (JR 9). VIII. Asymmetric Information and Market Failures (2 lectures). Information Economics (JR 8); Externalities; Public Goods. IX. Public Choice Theory (2 lectures). Social Choice and Arrow's Theorem (JR 6.2); Voting.	The grades will be determined as follows: problem sets 15%, midterm 35%, final exam 50%.	Geoffrey Jehle and Philip Reny [JR]: Advanced Microeconomic Theory, 2nd edition, Addison Wesley Pub Co, 2001, ISBN 0321079167.
Graduate	(first year)	**ECON 500a, General Economic Theory: Microeconomics**	recommendation	N/A	N/A	N/A	Introduction to optimization methods and partial equilibrium. Theories of utility and consumer behavior production and firm behavior. Introduction to uncertainty and the economics of information, and to noncompetitive market structures.	N/A	N/A	N/A
	(first year)	**ECON 501b, General Economic Theory: Microeconomics**	recommendation	N/A	N/A	N/A	General equilibrium and welfare economics. Allocation involving time. Public sector economics. Uncertainty and the economics of information. Introduction to social choice.	N/A	N/A	N/A
	N/A	**ECON 520a, Advanced Microeconomic Theory I.**	選択	N/A	N/A	N/A	A formal introduction to game theory and information economics. Alternative noncooperative solution concepts are studied and applied to problems in oligopoly, bargaining, auctions, strategic social choice, and repeated games.	N/A	N/A	N/A
	N/A	**ECON 521b, Advanced Microeconomic Theory II.**	選択	N/A	N/A	N/A	Contracts and the economics of organization. Topics may include dynamic contracts (both explicit and implicit), career concerns, hierarchies, Bayesian mechanism design, renegotiation, and corporate control.	I. Adverse Selection: The basic principal-agent model with adverse selection and its applications. II. Moral Hazard: The principal-agent model with moral hazard. III. Auction Theory: (i) First and second price auctions; (ii) Design of optimal auctions. IV. Bilateral Trading: (i) Two person double auctions; (ii) Efficient mechanisms for bilateral trading. V. Mechanism Design: (i) Implementation via dominant strategies and Bayesian Nash equilibrium; (ii) The revelation principle; (iii) Implementation of efficient outcomes. VI. Games with Communication: Correlated and communication equilibria. VII. Implementation Theory: Unique implementation in Nash and subgame perfect equilibria.	N/A	Textbookについての記載なし。 ただし、単元ごとのReading Listあり。
	N/A	**ECON 545a, Microeconomics**	選択	N/A	N/A	N/A	A survey of the main features of current economic analysis and of the application of the theory to a number of important economic questions, covering microeconomics and demand theory, the theory of the firm, and market structures.	N/A	N/A	N/A

C.1.3　ケンブリッジ大学



University of Cambridge – Economics
Undergraduate

Part (Year)	Courses	Compulsory
Part I (First Year)	Paper 1 Microeconomics	◎
	Paper 2 Macroeconomics	◎
	Paper 3 Quantitative Methods in Economics	◎
	Paper 4 Political and Sociological Aspects of Economics	◎
	Paper 5 British Economic History	◎
Part IIA (Second Year)	Paper 1 Microeconomic principles	◎
	Paper 2 Macroeconomic principles	◎
	Paper 3 Theory and Practice of Econometrics I	◎
	Paper 4 Economic Development	〇(1 paper)
	Paper 5 Modern Societies	
	Paper 6 Mathematics for Economists and Statisticians	
Part IIB (Third Year)	Paper 1 Microeconomic Principles and Problems	◎
	Paper 2 Macroeconomic Principles and Problems	◎
	Paper 3 Labour	〇(2 papers)
	Paper 4 Economic Theory and Analysis	
	Paper 5 Mathmatical Economics	
	Paper 6 Banking, Money and Finance	
	Paper 7 Public Economics	
	Paper 8 The Economics of Underdeveloped Countries	
	Paper 9 Industry	
	Paper 10 Theory and Practice of Econometrics II	
	Paper 11 Time Series and Financial Econometrics	
	Paper 12 A Subject in Economics	
	Paper 13 A Subject in Economics	
	Paper 14 A Subject in Economic History	
	Paper 15 A Subject in Economic History	
	Paper 16 Modern Britain	
	Paper 17 A Subject in the field of Sociology and Politics	
	(a) Gender and Society/ The Family	
	(b) The Sociology and Politics of South Asia	
	(c) Society, Politics and Culture in Latin America	
	(d) A Subject in Sociology 1: The Political Economy of Capitalism	
	Dissertation	◎

◎:必修
〇:選択必修

(注)
・paperは、以下のものを含む履修の単位である。
– lecture courses(講義)
– supervisions(少人数教育)
– examination(Part終了時の試験)
・paperによってはsupervisionsが含まれていないものもある。
・paperによっては他に提出課題があるものもある。
・lecture courseごとの試験はない。

University of Cambridge – Economics
Postgraduate (Diploma, M.Phil, PhD)

Programs	Year	Courses	区分	Compulsory
M.Phil		Three-week preparatory course in mathematics and statistics		◎
		S100 Microeconomics I	core courses	◎
		S200 Macroeconomics I		◎
		S300 Econometrics I		◎
		S110 Microeconomics II	advanced core courses	Option Bのみ ○ (2 course)
		S210 Macroeconomics II		
		S310 Econometrics II		
		S140 Industrial Organisation	Specialist Subjects	
		S220 Topics in Macroeconomics		
		S403 Asset Pricing		
		S410 Topics in Industrial and Financial Economics		
		S500 Development Economics		
		S501 The Economics of Poor Countries		
		S610 British Industrialisation		
		S620 Topics in Macroeconomic History		
		S650 Philosophical Issues in Economics		
		S660 The Methodology of Economics		
		S750 Labour Economics		
		S760 Economics of Networks		
PhD (coursework)	First	Advanced course in Economic Theory		○ (minimum: 80 hours)
		Advanced Econometrics I		
		Advanced Econometrics II		
		Topics in Advanced Macroeconomics		
		Computational Methods for Economics		
		※M.Phil Specialist Subjectsまたは他courseからの選択も可能		

◎:必修
○:選択必修

(注)
・経済学専攻のPostgraduate Coursesでは、次の3種類の学位プログラムを提供している。
(1)Diploma:first degreeが経済学ではない学生を対象とした9ヶ月のtaught course。経済学のsecond bachelor's degreeと同等のもの。
(2)M.Phil:Option A(PhD進学を希望しない学生向け)、Option B(PhD進学希望学生向け)に分かれる。
(3)PhD
→ここでは、(2)および(3)についてまとめている。

【M.Phil】
・上記の必修に加え、Dissertationが必要である。(Opetion A、Bとも)

【PhD】
・PhDの1年生が対象となるCertificate of Postgraduate Study (CPGS)は、次の4つのcomponetで構成される。
1. General research methods training.
2. Advanced coursework (minimum of 80 hours)
3. Writing a substantial dissertation (maximum length 20,000 words)
4. Attendance at: (i) a research workshop attended by Faculty members and research students, at which research students present both their own work and recent papers in the literature; (ii) research seminars given by outside speakers and Faculty members.
・PhDの2年生、3年生は、dessertation(博士論文)の執筆とCPGSの4.と同一のものが必須。

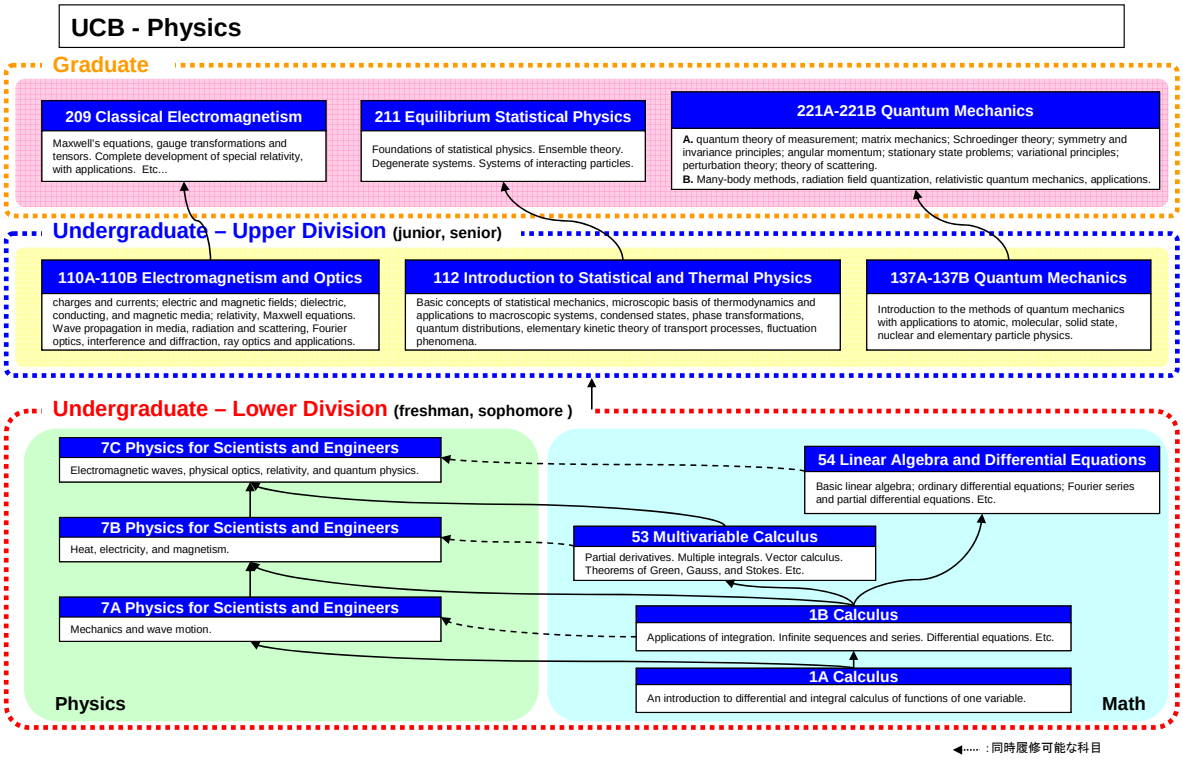
University of Cambridge
Structure of Subjects in Economics, Microeconomics

	Enrollment Period	Papers/Components	Requirement	Lecture courses	Size of the Subject	Aim of Lecture	Contents of the Subject (Lecture Items)	Grading	Textbooks
Undergraduate	Part I (First Year)	**Part I Microeconomics**	必修	**Introduction to Microeconomics**	4 lectures, weeks 1-2, Michaelmas Term	Overview of market and institutional allocations of resources.	N/A	N/A	Core readings are based on Varian, H., Intermediate Microeconomics.
				Introduction to Microeconomics: Consumer Theory	10 lectures, weeks 3-6, Michaelmas Term	The economics of consumer choice and market demand.	N/A		
				Introduction to Microeconomics: Strategic Interaction	4 lectures, weeks 7-8, Michaelmas Term	Games and strategic behaviour, insights of game theory.	N/A		
				Introduction to Microeconomics: Producer Theory	8 lectures, weeks 1-4, Lent Term	The economics of production, and of the firm's decision to supply output and demand factors of production.	N/A		
				Introduction to Welfare Economics and General Equilibrium	8 lectures, weeks 5-8, Lent Term	Pareto efficiency, competitive equilibrium and fundamental theorems.	N/A		
	Part IIA (Second Year)	**Part IIA Microeconomic principle**	必修	**Consumer and Producer Theory**	8 hours, weeks 1, 3-5, Michaelmas Term	This paper aims to provide a rigorous foundation of intermediate level microeconomic theory, forming the basis for both the more applied and the theoretical microeconomic papers in Part IIB. In addition to developing and extending topics familiar to students from Part I, such as consumer and producer theory, the course introduces important theoretical concepts such as asymmetric information, game theory and finance.	N/A	N/A	A selective reading list There are many excellent textbooks, including: - H.R. Varian (2003) Intermediate Microeconomics, 6th ed. - W. Nicholson (2005) Microeconomic Theory, 9th ed. - H. Gravelle and R. Rees (2004) Microeconomics,3rd ed. On game theory and I.O.: - D. Kreps (1990) Game Theory and Economic Modelling. - O. Shy (1995) Industrial Organization: Theory and Applications. A good book on applied welfare economics is: - J. Stiglitz (2000) Economics of the Public Sector, 3rd ed. * Individual lecturers will distribute specific reading lists in lectures.
				General Equilibrium and Trade Theory	8 hours, weeks 5-8, Michaelmas Term		N/A		
				Welfare Economics	8 hours, weeks 1-4, Lent Term		N/A		
				Game Theory and Industrial Organisation	8 lectures, weeks 5-8, Lent Term		N/A		
				Information Economics	8 hours, Easter Term		N/A		
	Part IIB (Third Year)	**Part IIB Microeconomic principle and Problems**	必修	**Social Cost-Benefit Analysis**	4 lectures weeks 5-8, Michaelmas Term	The aim of the paper is to illustrate the economic analysis of microeconomic problems and their potential solutions. The lectures incorporate comparative, theoretical and empirical approaches to economic problems and policies. They provide information on both the particular area of economic policy and the nature of the economic analysis that applies to it.	N/A	N/A	Readings - Armstrong, Cowan and Vickers, 1994. Regulatory Reform. - Barr, N., 1998. Economics of the Welfare State, 3rd ed. - Becker, G., 1975. Human Capital, 2nd ed. - Culyer, A.J. and J.P.Newhouse, Handbook of Health Economics, Vols 1-2 - Inman, R, ed., 1988. Managing the Service Economy. - OECD, Industrial Policies in OECD Countries, annual - Layard, R. and Glaister, S. 1994. Cost Benefit Analysis. - Oxford Review of Economic Policy, Spring 1997. Issue on competition in regulated industries. - Stiglitz, J., 1994. Whither Socialism? - Vickers, J.S. and Yarrow, G.K. 1988. Privatisation:An Economic Analysis. - Vickrey, W. 1994. Public Economics (edited by R. Arnott et.al) - Zweifel, P. and F.Breyer, 1997. Health Economics.
				Applied Welfare Economics	8 lectures, weeks 1-4, Michaelmas Term		N/A		
				Information and Incentives	8 lectures, weeks 1-4, Michaelmas Term		N/A		
				Topics in Applied Welfare Economics	weeks 1-8, Lent Term		N/A		
				The Foundations of Social Capital	8 lectures, weeks 1-4, Lent Term		N/A		
				Corporate Governance	2 two hour lectures, weeks 1-2, Lent Term		N/A		
Graduate (MPhil)		**S100 Microeconomics I**	必修		40 hours of lectures plus classes	The aim is to provide a rigorous graduate level training in microeconomic theory with opportunities to apply principles to empirical and policy problems. Topics covered include: consumer and producer theory; choice under uncertainty; general equilibrium theory; game theory; contract theory; industrial organisation.	N/A	(A) assessed by exam, 22% of the total marks (B) assessed by exam, 18% of the total marks	N/A
		S110 Microeconomics II	(B)のみ選択必修		20 hours of lectures plus classes	The aim is to build on Microeconomics I by providing an advanced treatment of some central concepts in microeconomic theory. The subjects covered are: further topics in equilibrium analysis; further game theory with applications; mechanism design with applications.	N/A	(B) assessed by exam, 9% of the total marks	N/A

* (A) designed for those students who do not intend to do a PhD
(B) designed for those students who do intend to do a PhD

C.2 物理学

C.2.1 カリフォルニア大学バークレー校



UC Berkeley – Physics
Undergraduate

Division	Year	Courses	区分	Requirement
Lower Division (freshman, sophomore)	(Freshman)	Mathematics 1A–1B. Calculus	Math	◎
	(Sophomore)	Mathematics 53. Multivariable Calculus		◎
	(Sophomore)	Mathematics 54. Linear Algebra and Differential Equations		◎
	(Freshman)	Physics 7A Physics for Scientists and Engineers (or H7A)		※◎
	(Sophomore)	Physics 7B Physics for Scientists and Engineers (or H7B)		※◎
	(Sophomore)	Physics 7C Physics for Scientists and Engineers (or H7C)		※◎
		8A. Introductory Physics		他専攻学生向け
		8B. Introductory Physics		他専攻学生向け
		10. Descriptive Introduction to Physics		他専攻学生向け
		(C10. Descriptive Introduction to Physics – no credit)		他専攻学生向け
		21. Physics of Music		
	Freshman	24. Freshman Seminars		
		39. Lower Division Physics Seminar		
		49. Supplementary Work in Lower Division Physics.		
	Sophomore	84. Sophomore Seminar		
		98. Directed Group Study		
		99. Supervised Independent Study		
Upper Division (junior, senior)		Mathematics 104. Introducation to Analysis	Math	★
		Mathematics 121A–B. Mathematical Tools for the Physical Sciences		
		Mathematics 185. Introduction to Complex Analysis		
	(Senior)	105. Analytic Mechanics		◎
		110A. Electromagnetism and Optics.		◎
	(Jr & Sr 3units each)	111. Modern Physics and Advanced Electrical Laboratory.		◎
		112. Introduction to Statistical and Thermal Physics.		◎
	(Junior)	137A. Quantum Mechanics		◎
	(Junior)	137B. Quantum Mechanics		◎
		108. Laser Physics		○
		110B. Electromagnetism and Optics.		
		124. Introductory Nuclear Physics		
		129A–129B. Particle Physics		
		138. Modern Atomic Physics		
		139. Special Relativity and General Relativity		
		141A–141B. Solid State Physics		
		142. Introduction to Plasma Physics		
		C161. Relativistic Astrophysics and Cosmology		
		177. Principles of Molecular Biophysics		
		C191. Quantum Information Science and Technology		
		100. Communicating Physics and Physical Science		
		132. Contemporary Physics		
		136. Applied Quantum Mechanics		
		H190. Physics Honors Course		
	Senior	H195A–H195B. Senior Honors Thesis Research		
		198. Directed Group Study		
		199. Supervised Independent Study		

★（大学院進学希望者）

◎：必修
○：選択必修
★：履修を推奨
※：prerequisites（前提履修科目）

（注）
・Lower Divisionのコースには、全学部の学生を対象としたものも含まれる。
・Yearの( )は、履修モデル

UC Berkeley – Physics
Graduate(Ph.D)

Year	Courses	Requirement
(First)	209. Classical Electromagnetism	◎
	211. Equilibrium Statistical Physics	◎
	221A. Quantum Mechanics	◎
	221B. Quantum Mechanics	◎
	251. Introduction to Graduate Research in Physics	
	300. GSI Training Seminar	
	205A. Advanced Dynamics	
	205B. Advanced Dynamics	
	208A. Introduction to Quantum Electronics and Nonlinear Optics	
	208B. Introduction to Quantum Electronics and Nonlinear Optics	
	212. Nonequilibrium Statistical Physics	
	216. Special Topics in Many-Body Physics.	
	222. Special Topics in Mathematical Physics	
	223. Applications of Group Theory in Modern Physics	
	226. Particle Physics Phenomenology	
	C228. Extragalactic Astronomy and Cosmology	
	229A. Standard Model of Particle Physics I-Ⅲ	
	230A. Quantum Field Theory I-Ⅱ	
	231. General Relativity	
	240A-240B. Quantum Theory of Solids	
	242A-242B. Theoretical Plasma Physics	
	250. Special Topics in Physics	
	C254. High Energy Astrophysics	
	C285. Theoretical Astrophysics Seminar	
	290A-290Z. Seminar	
	C290C. Cosmology	
	290N. Seminar in Non-Neutral Plasmas	
	290Q. Seminar in Quantum Optics	
	295. Special Study for Graduate Students	
	299. Research	
	602. Individual Study for Doctoral Students	

◎:必修

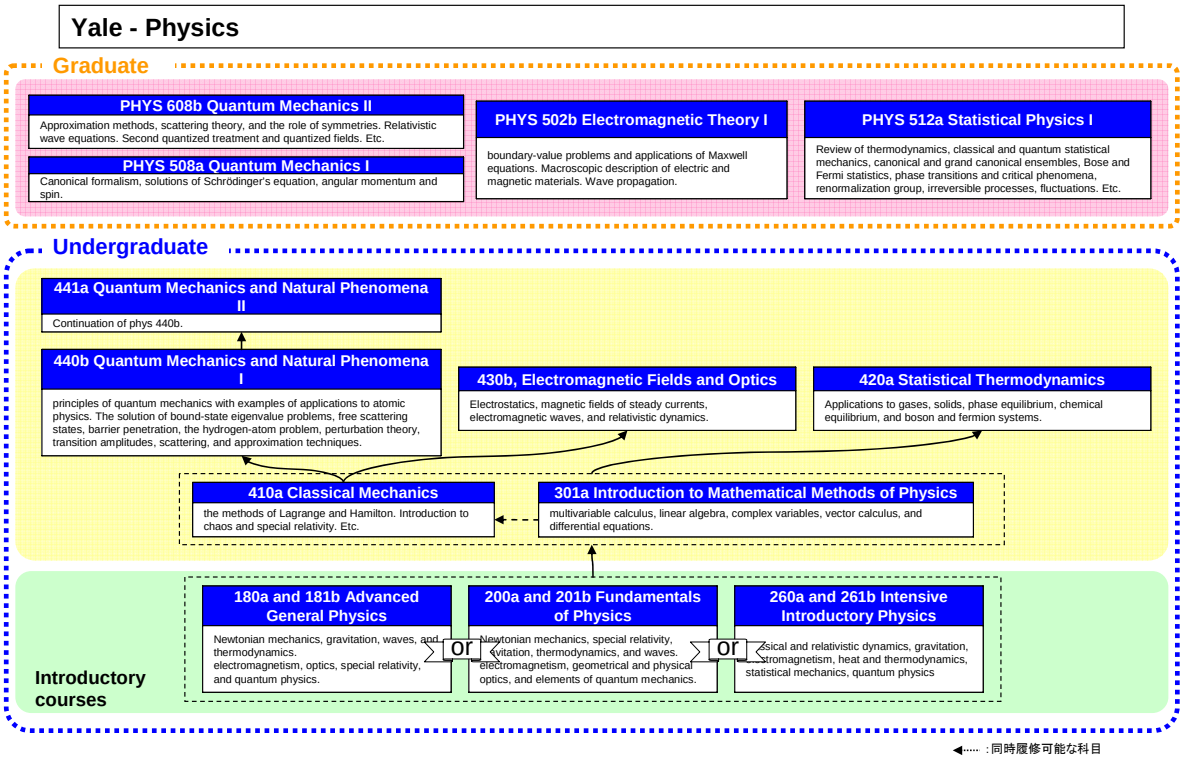
（注）
・Ph.D programのみで、M.A. programはない。
・Yearの( )は、履修モデル
・必修に加えて以下の履修が必要。
19 units (five semester courses) of material selected from upper division or graduate courses (not including any upper division material required for the undergraduate major), of which at least 11 units must be in the 200 series courses.

University of California, Berkeley
Structure of Subjects in Physics

	Enrollment Period		Subjects	Requirement	Size of the Subject	Prerequisite subjects	Aim of Lecture	Contents of the Subject (Lecture Items)	Grading	Textbooks
Undergraduate	Lower division (freshman, sophomore)	(Freshman)	**7A. Physics for Scientists and Engineers**	必修	4 credits. Three hours of lecture and four hours of laboratory/ workshop per week	High school physics; Math 1A or 1AS; Math 1B or 1BS	The students will learn the physics of the multiparticle system and the scattering problem based on the knowledge of quantum mechanics which has been learned.	Mechanics and wave motion See "Syllabus".	Grades will be determined from a weighting of all the elements of the course approximately as follows: - first midterm exam 20% - second midterm exam 20% - final exam 40% - homework 15% - laboratory/discussion/quizzes 5%	Required Texts: (1) D. C. Giancoli, Physics for Scientists and Engineers, Volume I, 4th edition. We will cover chapters 1 through 15, including most sections marked Optional. You will be expected to read those sections of the book relevant to a given lecture before class. (2) Birkett and Elby, Physics 7A Workbook is required for the Discussion/Lab sessions. The workbook consists of qualitative questions and quantitative problems that will help you gain mastery of the material. In addition, the workbook contains laboratory handouts which you will complete during the course's various labs.
		(Sophomore)	**7B. Physics for Scientists and Engineers**	必修	4 credits. Three hours of lecture and four hours of laboratory/ workshop per week	7A, Math 1A-1B,Math 53		Heat, electricity, and magnetism See "syllabus".	Exams and Grades: There will be two midterm examinations and a final exam. One problem on each exam will be taken directly from the homework assignments, and many of the other problems will be of similar form and difficulty as the homework problems. Dates and times are listed on the following page. For each midterm you will be allowed an equation sheet, whose size will be announced in the weeks leading up to the exams. A grade of "Incomplete" will only be given under dire circumstances beyond a student's control, and only when work already completed is of at least C quality. University guideline specifies that in lower division courses, the total percentage of students getting A and B should not exceed 65%. The good news is that 65% of the class will be getting A's and B's!	(1) D. C. Giancoli, Physics for Scientists and Engineers, Volumes I and II, 3rd edition. We will cover chapters 17 through 32, including most sections marked "Optional." You will be expected to read those sections of the book relevant to a given lecture before class. This is a required text. (2) 7B Workbook. This will be packaged with Giancoli in the campus bookstores. We will be using these workbooks in section. (3) Elby, Portable TA: Problem Solving Guide, Volume 1. This extremely popular resource contains practice problems about classical mechanics with completely worked out solutions. It is meant to be worked, not read. These practice problems are for your own benefit; we will not collect your work on them. We suggest working through at least some of the problems in Elby before attempting each week's homework assignment. This is a required text.
		(Sophomore)	**7C. Physics for Scientists and Engineers**	必修	4 credits. Three hours of lecture, one hour of discussion, and three hours of laboratory per week	7A-7B, Math 1A-1B, Math 53, 54		Electromagnetic waves, physical optics, relativity, and quantum physics	Weighting: Weekly Take-Home Quizes 5% Labs 10% Homework 10% First Midterm 20% Second Midterm 20% Final Exam 35%	- Giancoli, Physics for Scientists and Engineers, Custom Vol. 3 - Tipler and Llewellyn, Modern Physics, 4th edition - Physics 7C Lab Manual, available at Copy Central
	Upper division (junior, senior)	(junior or senior)	**110A. Electromagnetism and Optics**	必修	4 credits. Three hours of lecture and one hour of discussion per week.	N/A	A course emphasizing electromagnetic theory and applications; charges and currents; electric and magnetic fields; dielectric, conducting, and magnetic media; relativity, Maxwell equations. Wave propagation in media, radiation and scattering, Fourier optics, interference and diffraction, ray optics and applications.	N/A	N/A	Griffiths INTRODUCTION TO ELECTRODYNAMICS, 3rd Ed., 1999, Prentice Hall
			110B. Electromagnetism and Optics	大学院進学希望者へ推奨	4 credits. Three hours of lecture and one hour of discussion per week.	Math 53, 54, Physics (H)7ABC, and 110A		See "Course Outline".	25% problem sets, 35% in-class exams, 40% final exam. Letters and Science rules limit the fraction of A's to ~45%. No minimum number of C's, D's or F's need be given.	Texts: · Griffiths, Introduction to Electrodyamics (3rd ed., Prentice-Hall, 1999, required). · Pedrotti & Pedrotti, Introduction to Optics (3rd ed., Prentice-Hall, 2006, required). · If you are planning to attend physics graduate school, and cash flow is not a major issue, it would be smart now to acquire Jackson, Classical Electrodynamics (3rd ed., Wiley). It is useful in this course.
		(junior or senior)	**112. Introduction to Statistical and Thermal Physics.**	必修	4 credits. Three hours of lecture and one hour of discussion per week.	N/A	N/A	Basic concepts of statistical mechanics, microscopic basis of thermodynamics and applications to macroscopic systems, condensed states, phase transformations, quantum distributions, elementary kinetic theory of transport processes, fluctuation phenomena.	N/A	Kittel & Kroemer THERMAL PHYSICS, 2nd Ed., 1980, Freeman
		(junior)	**137A. Quantum Mechanics**	必修	4 credits. Three hours of lecture and one hour of discussion per week.	7A-7C and Mathematics 53-54, or equivalent.	Introduction to the methods of quantum mechanics with applications to atomic, molecular, solid state, nuclear and elementary particle physics.	N/A	35% problem sets, 30% midterms, 35% final	Course text: Introduction to Quantum Mechanics (2nd Edition), Griffiths
		(junior)	**137B. Quantum Mechanics**	必修	4 credits. Three hours of lecture and one hour of discussion per week.	Physics 137A or equivalent.		I. Brief review of basic principles of quantum mechanics, concentrating on angular momentum and quantum mechanics of multiple identical particles. II. Time-independent approximation methods. Fine structure of atoms. III. Time-dependent approximation methods. Fermi's Golden Rule. IV. Interaction of matter and electromagnetic fields. V. Scattering theory. Approximation methods for scattering states. VI. Quantum statistics. Bose and Fermi gases.	2 midterms (80 minutes), October 9 and November 13, plus final exam. Grading: Problem sets 30% Midterms 15% each Final 40%	required textbook Bransden and Joachain, Quantum Mechanics (second edition)
Graduate		(First Year)	**209. Classical Electromagnetism**	必修	5 credits. Three hours of lecture and one hour of discussion per week.	110A-110B or consent of instructor.	N/A	Maxwell's equations, gauge transformations and tensors. Complete development of special relativity, with applications. Plane waves in material media, polarization, Fresnel equations, attenuation, and dispersion. Wave equation with sources, retarded solution for potentials, and fields. Cartesian and spherical multipole expansions, vector spherical harmonics, examples of radiating systems, diffraction, and optical theorem. Fields of charges in arbitrary motion, radiated power, relativistic (synchrotron) radiation, and radiation in collisions.	N/A	Jackson CLASSICAL ELECTRODYNAMICS, 3rdEd., 1999, Wiley
			211. Equilibrium Statistical Physics	必修	4 credits. Three hours of lecture and one hour of discussion per week.	112 or equivalent.	N/A	Foundations of statistical physics. Ensemble theory. Degenerate systems. Systems of interacting particles.	N/A	N/A
			221A. Quantum Mechanics	必修	5 credits. Three hours of lecture and one hour of discussion per week.	137A-137B or equivalent.	N/A	Basic assumptions ofquantum mechanics; quantum theory of measurement; matrix mechanics; Schroedinger theory; symmetry and invariance principles; theory of angular momentum; stationary state problems; variational principles; time independent perturbation theory; time dependent perturbation theory; theory of scattering.	N/A	J.J. Sakurai MODERN QUANTUM MECHANICS, 1994, 2ND.Ed., Addison Wesley
			221B. Quantum Mechanics	必修	5 credits. Three hours of lecture and one hour of discussion per week.	221A.	N/A	Many-body methods, radiation field quantization, relativistic quantum mechanics, applications.	N/A	N/A

( ):履修モデル

C.2.2　イェール大学


Yale - Physics
Graduate
PHYS 608b Quantum Mechanics II
Approximation methods, scattering theory, and the role of symmetries. Relativistic wave equations. Second quantized treatment and quantized fields. Etc.
PHYS 508a Quantum Mechanics I
Canonical formalism, solutions of Schrödinger's equation, angular momentum and spin.
PHYS 502b Electromagnetic Theory I
boundary-value problems and applications of Maxwell equations. Macroscopic description of electric and magnetic materials. Wave propagation.
PHYS 512a Statistical Physics I
Review of thermodynamics, classical and quantum statistical mechanics, canonical and grand canonical ensembles, Bose and Fermi statistics, phase transitions and critical phenomena, renormalization group, irreversible processes, fluctuations. Etc.
Undergraduate
441a Quantum Mechanics and Natural Phenomena II
Continuation of phys 440b.
440b Quantum Mechanics and Natural Phenomena I
principles of quantum mechanics with examples of applications to atomic physics. The solution of bound-state eigenvalue problems, free scattering states, barrier penetration, the hydrogen-atom problem, perturbation theory, transition amplitudes, scattering, and approximation techniques.
430b, Electromagnetic Fields and Optics
Electrostatics, magnetic fields of steady currents, electromagnetic waves, and relativistic dynamics.
420a Statistical Thermodynamics
Applications to gases, solids, phase equilibrium, chemical equilibrium, and boson and fermion systems.
410a Classical Mechanics
the methods of Lagrange and Hamilton. Introduction to chaos and special relativity. Etc.
301a Introduction to Mathematical Methods of Physics
multivariable calculus, linear algebra, complex variables, vector calculus, and differential equations.
Introductory courses
180a and 181b Advanced General Physics
Newtonian mechanics, gravitation, waves, and thermodynamics. electromagnetism, optics, special relativity, and quantum physics.
or
200a and 201b Fundamentals of Physics
Newtonian mechanics, special relativity, gravitation, thermodynamics, and waves. electromagnetism, geometrical and physical optics, and elements of quantum mechanics.
or
260a and 261b Intensive Introductory Physics
sical and relativistic dynamics, gravitation, stromagnetism, heat and thermodynamics, statistical mechanics, quantum physics
:同時履修可能な科目

Yale – Physics

Yale College (undergraduate course)

Year	Courses	区分	Requirement <B.S. Degree>	<Intensive B.S. Degree>	
	Math 115a Calculus of Functions of One Variable II, Math 120a Calculus of Functions of Several Variables	Math	※○		phys 180, 181bとセット履修
	Math 120b Calculus of Functions of Several Variables, Math 225b Linear Algebra and Matrix Theory, or Math 222b Linear Algebra with Applications				phys 200a, 201bとセット履修
	Math 230 Vector Calculus and Linear Algebra				phys 260a, 261bとセット履修
freshman	phys 095a Radiation, Nuclear Physics, and the Universe				
	phys 110a or b Developments in Modern Physics	Introductory lecture courses	他専攻学生向け		
	phys 150a and 151b General Physics		他専攻学生向け		
	phys 180a and 181b Advanced General Physics		※○		
	phys 200a and 201b Fundamentals of Physics				
	phys 260a and 261b Intensive Introductory Physics				
	phys 165La and 166Lb General Physics Laboratory	Introductory Laboratories			
	phys 205La or Lb Modern Physical Measurement		※◎		
	phys 206La or Lb Modern Physical Measurement		※◎		
	phys 301a Introduction to Mathematical Method of Physics (or other advanced mathematics course)		◎		
	phys 381La Experimental Research Studies I			○	
	phys 382Lb Experimental Research Studies II				
	phys 401a Advanced Classical Physics: From Newton to Einstein I		◎		
	phys 402b Advanced Classical Physics: From Newton to Einstein II		◎		
	phys 410a Classical Mechanics			◎	
	phys 420a Statistical Thermodynamics			◎	
	phys 430b Electromagnetic Fields and Optics			◎	
	phys 439a/aphy 439a Basic Quantum Mechanics		○		
	phys 440b Quantum Mehcanics and Natural phenomena I			◎	
	phys 441a Quantum Mehcanics and Natural phenomena II			◎	
	meng 285b Introduction to Materials Science				
	phys 295a/astr 255a Research Methods in Astrophysics				
	phys 341a Biological Physics				
	phys 342a/g&g 342a Introduction to Earth and Environmental Physics				
	phys 343b/astr 343b Gravity, Astrophysics, and Cosmology				
	phys 344b Quantum and Nanoscale Physics				
	phys 448a/aphy 448aG Solid-State Physics I.				
	phys 449b/aphy 449bG Solid-State Physics II				
	phys 460a Mathematical Methods of Physics				▲
Senior	Senior essay	Senior requirement	○		
	phys 471a and 472b Independent Projects in Physics				
	aphy 471a and 472b Special Projects				

◎：必修
○：選択必修
※：prerequisites（前提履修科目）
▲：大学院、学部共通

（注）
・Introductoryコースには、全学部の学生を対象としたものも含まれる。
・PhysicsのMajorは2種類：B.S. Degree、および Intensive B.S. Degree（大学院進学者向け）
・B.S. Degreeは、prerequisites、senior essay以外に8コース、Intensive B.S. Degreeは10コースの履修が必要。

Yale – Physics
Graduate(Ph.D)

Year	Courses	区分	Requirement	
(Year 1)	PHYS 500a, Dynamics.	core courses	◎	
	PHYS 502b, Electromagnetic Theory I.		◎	
	PHYS 506a, Mathematical Methods of Physics.		◎	▲
	PHYS 508a, Quantum Mechanics I.		◎	
	PHYS 512a, Statistical Physics I		◎	
	PHYS 608b, Quantum Mechanics II.		◎	
	PHYS 504Lb, Modern Physics Measurements		○	
	PHYS 990a and b, Special Investigations.			
(Year 2)	PHYS 609a, Relativistic Field Theory I.		○	
	PHYS 610b, Quantum Many-Body Theory.			
	PHYS 628b, Statistical Physics II.			
(Year 1 or 2)	PHYS 515a, Topics in Modern Physics Research.			
	PHYS 602a, Classical Field Theory.			
	PHYS 522a, Introduction to Atomic Physics.			
	PHYS 523a, Biological Physics.			
	PHYS 524a, Introduction to Nuclear Physics.			
	PHYS 526b, Introduction to Elementary Particle Physics.			
	PHYS 538a, Introduction to Relativistic Astrophysics and General Relativity.			
	PHYS 548a and 549b, Solid State Physics I and II.			▲
	PHYS 570a, High-Energy Astrophysics.			▲
	PHYS 600b, Cosmology.			
	PHYS 624b, Group Theory.			▲
	PHYS 630b, Relativistic Field Theory II.			
	PHYS 631a, Computational Physics I			▲
	PHYS 633b, Introduction to Superconductivity.			
	PHYS 634a, Mesoscopic Physics.			
	PHYS 650a, Theory of Solids I.			
	PHYS 651b, Theory of Solids II.			
	PHYS 661b, The Art of Data Analysis.			
	PHYS 662a, Special Topics in Particle Physics: Beyond the Standard Model.			
	PHYS 663b, Special Topics in Cosmology and Particle Physics.			
	PHYS 664b, Special Topics in Nuclear Physics.			
	PHYS 667a, Special Topics in Condensed Matter Physics.			
	PHYS 668b, Special Topics in Geometry and Modern Field Theory.			
	PHYS 671b, Special Topics in Experimental Nuclear and Particle Physics.			
	PHYS 672a or b, Special Topics in Experimental Physics.			
	PHYS 673a or b, Special Topics in Atomic Physics.			
	PHYS 674b, Quantum Information, Quantum Cryptography, and Quantum			
	PHYS 675b, Special Topics in Optics.			
	PHYS 676a, Optical Properties of Semiconductors.			
	PHYS 677a, Noise, Dissipation, Amplification, and Information.			
	PHYS 678b, Computing for Scientific Research.			
	PHYS 679a, Nonlinear Optics.			

◎:必修
○:選択必修
▲:大学院、学部共通

(注)
・Ph.D programのみでM.A. programはない。
→ただし、M.phil degree、M.S. degree (en route to the Ph.D.)の取得は可能。
・Yearの( )は、履修モデル
・その他のrequirements
– Year 1 には、上記のコースの他、Summer internship が必修になっている。
– dissertation(博士論文)の提出が必須。
– 上記コースの受講はYear 2まで。Dissertation research を Year 2 の第2セメスターより開始。
(別紙"Typical Time Line for Academic Requirements"参照)

Yale – Physics
Graduate(Ph.D)

Typical Time Line for Academic Requirements

Year 1:

First semester
Required core courses (PHYS 500a; PHYS 508a; PHYS 506a)
Second semester
Required core courses (PHYS 502b; PHYS 512b; PHYS 608b)
Advanced laboratory course (PHYS 504Lb) or experimental Special Investigation (PHYS 990a,b)
Summer
Summer internship –– Appointment as Assistant in Research
For international students –– English language training to prepare for SPEAK test

Year 2:

First semester
Qualifying Exam at beginning of first semester given on the first Friday of the semester
Continue with required course requirements (PHYS 609a or PHYS 610a/b or PHYS 628b); and one or two electives
Second semester
Complete courses (one or two additional electives)
Finalize thesis advisor
Start dissertation research
Summer
Work as an Assistant in Research with advisor

Year 3:

Establish ``Core Thesis Committee'' of 3 faculty including the thesis advisor
Admission to Candidacy, including written Thesis Prospectus and oral defense of thesis prospectus to core thesis committee
For international students –– must pass SPEAK test
Dissertation research

Year 4–5:

Continue dissertation research
Annual Oral presentation of research
Annual meeting with core committee to review progress towards disseration
Yearly Dissertation Progress Report due by May 1

Years 5–6:

Continue dissertation research and prepare dissertation draft
Thesis Defense and oral examination by committee of five
Submission of written dissertation
Reader's reports due after submission
Award of degree

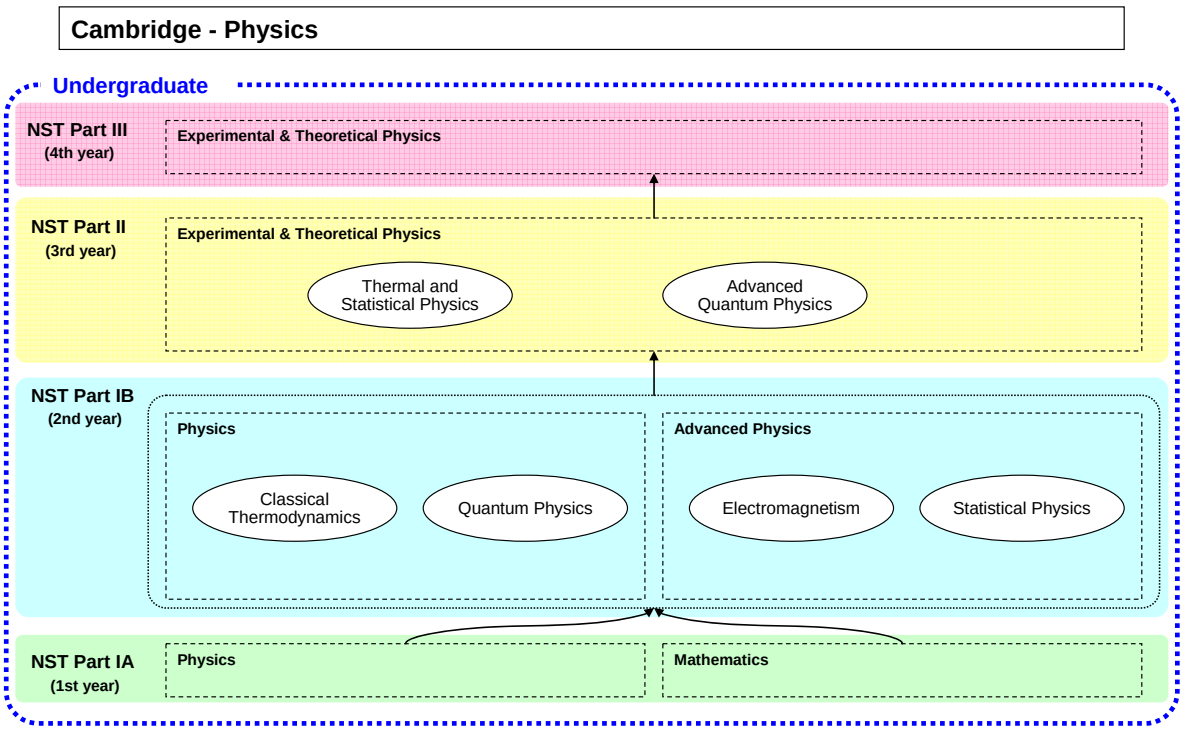
http://xpcs.physics.yale.edu/Handbook/node4.html

Yale University
Structure of Subjects in Physics

	Enrollment	Subjects	Requirement	Size of the Subject	Prerequisite subjects	Aim of Lecture	Contents of the Subject (Lecture Items)	Grading	Textbooks
Undergraduate	N/A	**phys 180a and 181b, Advanced General Physics.**	選択必修	2 course credit (1 course credit per term). Lect. 3 hours and disc. 1 hour per week	Concurrently with math 115a and 120b or equivalents.	A broad introduction to classical and modern physics for students who have some previous preparation in physics and mathematics.	phys 180a covers Newtonian mechanics, gravitation, waves, and thermodynamics. phys 181b covers electromagnetism, optics, special relativity, and quantum physics.	N/A	N/A
	N/A	**phys 200a and 201b, Fundamentals of Physics.**		2 course credit (1 course credit per term). Lect. 3 hours and disc. 2 hours per week	Prerequisite: math 115a or b or equivalent. math 120a should be taken concurrently. It is suggested that math 222b or 225b be taken concurrently with phys 201b.	A thorough introduction to the principles and methods of physics for students who have good preparation in physics and mathematics. Emphasis on problem solving and quantitative reasoning.	phys 200a covers Newtonian mechanics, special relativity, gravitation, thermodynamics, and waves. phys 201b covers electromagnetism, geometrical and physical optics, and elements of quantum mechanics.	N/A	N/A
	N/A	**phys 260a and 261b, Intensive Introductory Physics.**		2 course credit (1 course credit per term). 3 hours of lecture per week	Concurrently with math 230, phys 301a, or equivalent.	The major branches of physics—classical and relativistic dynamics, gravitation, electromagnetism, heat and thermodynamics, statistical mechanics, quantum physics—covered at a sophisticated level. For students majoring in the physical sciences, Mathematics, and Philosophy who have excellent training in and a flair for mathematical methods and quantitative analysis.	N/A	N/A	N/A
	N/A	**phys 301a, Introduction to Mathematical Methods of Physics**	必修	1 course credit. 3 hours of lecture per week	Prerequisite: phys 180a, 181b, or 200a, 201b, or 260a, 261b, or permission of instructor. Recommended to be taken concurrently with phys 401a or 410a.	Designed to give accelerated access to 400- level courses by providing, in one term, the essential background in mathematical methods.	Topics include multivariable calculus, linear algebra, complex variables, vector calculus, and differential equations.	N/A	N/A
	N/A	**phys 410a, Classical Mechanics**	必修 (Intensive B.S. Degree)	1 course credit. 3 hours of lecture per week	Prerequisite: phys 180a, 181b, or 200a, 201b, or 260a, 261b. To be taken concurrently with phys 301a or other advanced mathematics course.	An advanced treatment of mechanics, with a special focus on the methods of Lagrange and Hamilton. Lectures and problems dealing with the mechanics of particles, systems of particles, and rigid bodies, as well as free and forced oscillations. Introduction to chaos and special relativity.	N/A	N/A	N/A
	N/A	**phys 420a, Statistical Thermodynamics**	必修 (Intensive B.S. Degree)	1 course credit. 3 hours of lecture per week	Prerequisites: phys 301a and 410a or equivalents.	An introduction to the laws of thermodynamics and their theoretical explanation by statistical mechanics. Applications to gases, solids, phase equilibrium, chemical equilibrium, and boson and fermion systems.	N/A	N/A	N/A
	N/A	**phys 430b, Electromagnetic Fields and Optics**	必修 (Intensive B.S. Degree)	1 course credit. 3 hours of lecture per week	Prerequisites: phys 301a and 410a or equivalents.	N/A	Electrostatics, magnetic fields of steady currents, electromagnetic waves, and relativistic dynamics. Provides a working knowledge of electrodynamics.	N/A	N/A
	N/A	**phys 440b, Quantum Mechanics and Natural Phenomena I**	必修 (Intensive B.S. Degree)	1 course credit. 3 hours of lecture per week	Prerequisites: phys 410a or 401a, 402b.	The first term of a two-term sequence covering principles of quantum mechanics with examples of applications to atomic physics. The solution of bound-state eigenvalue problems, free scattering states, barrier penetration, the hydrogenatom problem, perturbation theory, transition amplitudes, scattering, and approximation techniques.	N/A	N/A	N/A
	N/A	**phys 441a, Quantum Mechanics and Natural Phenomena II.**	必修 (Intensive B.S. Degree)	1 course credit. 3 hours of lecture per week	Continuation of phys 440b. Prerequisite: phys 440b.	N/A	N/A	N/A	N/A
Graduate	(Year 1)	**PHYS 502b, Electromagnetic Theory I.**	必修	3 hours of lecture per week	N/A	N/A	Classical electromagnetic theory including boundary-value problems and applications of Maxwell equations. Macroscopic description of electric and magnetic materials. Wave propagation.	N/A	N/A
	(Year 1)	**PHYS 508a, Quantum Mechanics I**	必修	3 hours of lecture per week	N/A	N/A	The principles of quantum mechanics with application to simple systems. Canonical formalism, solutions of Schrödinger's equation, angular momentum and spin.	N/A	N/A
	(Year 1)	**PHYS 512a, Statistical Physics I**	必修	3 hours of lecture per week	N/A	N/A	Review of thermodynamics, the fundamental principles of classical and quantum statistical mechanics, canonical and grand canonical ensembles, identical particles, Bose and Fermi statistics, phase transitions and critical phenomena, renormalization group, irreversible processes, fluctuations.	N/A	N/A
	(Year 1)	**PHYS 608b, Quantum Mechanics II**	必修	3 hours of lecture per week	N/A	N/A	Approximation methods, scattering theory, and the role of symmetries. Relativistic wave equations. Second quantized treatment of identical particles. Elementary introduction to quantized fields.	N/A	N/A

( ):履修モデル

C.2.3　ケンブリッジ大学



*NST: Natural Sciences Tripos

University of Cambridge – Physics (Natural Sciences Tripos)
Undergraduate

Part (Year)	Courses	区分	Compulsory
Part IA (First Year)	Elementaray Mathematics for Biologists	Math	（対象外）
	Mathematics		◎
	Quantitative Biology		（対象外）
	Physics	Physics	◎
	Biology of Cells	Other subjects	○ (choose 2)
	Chemistry		
	Evolution and Behavior		
	Geology		
	Materials and Mineral Sciences		
	Physiology of Organisms		
	Computer Science		
Part IB (Second Year)	Physics	Physics	◎
	Advanced Physics		◎
	Mathematics	Math	○ ★
	Animal Biology	Other subjects	
	Biochemistry and Molecular Biology		
	Cell and Developmental Biology		
	Chemistry A		
	Chemistry B		
	Ecology		
	Experimental Psychology		
	Geological Sciences A		
	Geological Sciences B		
	History & Philosophy of Science		
	Materials Science and Metallurgy		
	Mineral Sciences		
	Neurobiology		
	Pathology		
	Pharmacology		
	Physiology		
	Plant and Microbial Sciences		
Part II Option A (Third Year)	Experimental and Theoretical Physics	Physics	○
Part II Option B & Part III (3rd & 4th Year)	Experimental and Theoretical Physics	Physics	

◎：必修
○：選択必修
★：履修を推奨

（注）
・Natural Sciences Triposでは、1、2年次には幅広い分野を履修し、3年次に専門分野に特化する。
Part IA(First Year)：数学1科目+3科目（7科目から選択）が必修
Part IB(Second Year)：3科目（20科目から選択）が必修
→ここでは、3年次にExperimental and Theoretical Physicsを選択する場合の前提履修科目についても◎としている。
・Natural Sciencesでは専門分野により修業年数が異なる。Physicsの場合は、3年コースと4年コースの2種類がある。
– 3年コースではB.A.degree、4年コースではB.A.degreeおよびM.Sci. degree (Master of Natural Sciences)が取得できる。

University of Cambridge – Physics
Postgraduate (M.Phil, PhD)

・物理学専攻のPostgraduate Coursesでは、次の2種類の学位プログラムを提供している。
(1)M.Phil (one year): 受け入れ学生数は限られている。lectures and relevant practical work を含む。
(2)PhD (three years): ほとんどの学生はこちらに所属。
– PhDでは、必修となっている講義はない。
– セミナーと学外のconferenceへの参加が奨励されている。
– 最終試験には、学位論文の提出、学内外の試験官による口頭試験が含まれる。

University of Cambridge – Physics

Undergraduate

Part (Year)	Courses			区分	<Option A> Compulsory	<Option B>	Exam
Part IA (First Year)	Physics	Lecture courses	Principles of Relativity, Mechanics and Fields		◎		*
			Electromagnetism, Oscillations and Waves		◎		
			Experimental Physics		◎		
			Quantum Physics and the Physics of Large Systems		◎		
			Revision Lectures		◎		
		Practical class	Experimental Physics		◎		
Part IB (Second Year)	Physics	Lecture courses	Oscillations, Waves and Optics		◎		*
			Classical Thermodynamics		◎		
			Experimental Methods		◎		*
			Quantum Physics		◎		
		Practical class	Systems and Measurement		◎		
			Waves and Optics		◎		
	Advanced Physics	Lecture courses	Electromagnetism		◎		*
			Classical Dynamics		◎		
			Statistical Physics		◎		*
			Methods of Mathematical Physics		◎(IB Math 選択学生向け)		
			Mathematics and Theoretical Physics		◎(IB Math 非選択学生向け)		
		Practical class	Systems and Measurement		◎		
			Wave and Optics		◎		
Part II (Third Year)	Experimental and Theoretical Physics	Core Lectures	Thermal and Statistical Physics		◎		* paper 1
			Relativity, Electrodynamics and Light		◎		* paper 2
			Advanced Quantum Physics		◎		
		Optional Lectures	Astorophysics		○ (choose 2)	○ (choose 4 or 3)	* paper 3
			Particle and Nuclear Physics				
			Soft Condensed Matter and Biophysics				* paper 4
			Quantum condensed Matter Physics				
		Further Work	Computational Physics		◎		
			Physics in Action		◎	(対象外)	
			Theoretical Physics TP1		○ (choose 3)	○ (choose 2 or 3)	
			Theoretical Physics TP2				
			Experiment E1				
			Experiment E2				
			Research Review				
			Physics Education				
			Long Vacation project				
			Concepts in Physics		★		
Part III (Fourth Year)	Experimental and Theoretical Physics	Major Options	Advanced Quantum Condensed Matter Physics		○ (choose 3)		* 各科目で試験を実施
			Soft Matter				
			Astrophysics and Cosmology				
			Particle Physics				
			Physics of the Earth as a Planet				
			Quantum Condensed Matter Field Theory				
			Classical Field Theory and Gravitation				
			Quantum Field Theory	Math			
		Minor Options	Gauge Field Theory	Theoretically biased	○ (choose 3)		* 各科目で試験を実施
			Phase Transitions and Collective Phenomena				
			Information Theory, Pattern Recognition and Neural Networks				
			Superconductivity and Quantum Coherence	Condensed-Matter Physics			
			Quantum Electronics in Semiconductors				
			From Quantum Optics to Quantum Matter				
			Materials, Electronics and Renewable Energy				
			The Frontiers in Experimental Condensed Matter Physics				
			The Frontiers of Particle Physics	Other			
			The Frontiers of Observational Astrophysics				
			Medical Physics				
			Biological Physics				
			Advanced Quantum Field Theory (option 2つ分に相当)	Math			
			Entrepreneurship				
			Examples Classes in General Physics		◎		
			Project Work		◎		
		Non-examinable	Philosophy of Physics				
			Cavendish Physical Society seminars				

◎:必修
○:選択必修
★:履修を推奨

(注)
・Natural Sciences Triposでは専門分野により修業年数が異なる。Physicsの場合は、3年コースと4年コースの2種類がある。
 – 3年コースではB.A.degree、4年コースではB.A.degreeおよびM.Sci. degree (Master of Natural Sciences)が取得できる。
 – Part II (Third Year) は、Option A(3年コース)、Option B(4年コース)に分かれる。
・lecture coursesの他にsupervisions(3名程度の少人数教育)の履修が必須。
・PartIA、IB、IIの試験は、1または複数の講義で扱う分野が対象となる。
・Part IIIでの評価
 – Project ・・・ 1/3
 – Major Options (各科目で試験を実施) ・・・ 1/3
 – Minor Options (各科目で試験を実施) ・・・ 1/6
 – General Physics Paper ・・・ 1/6

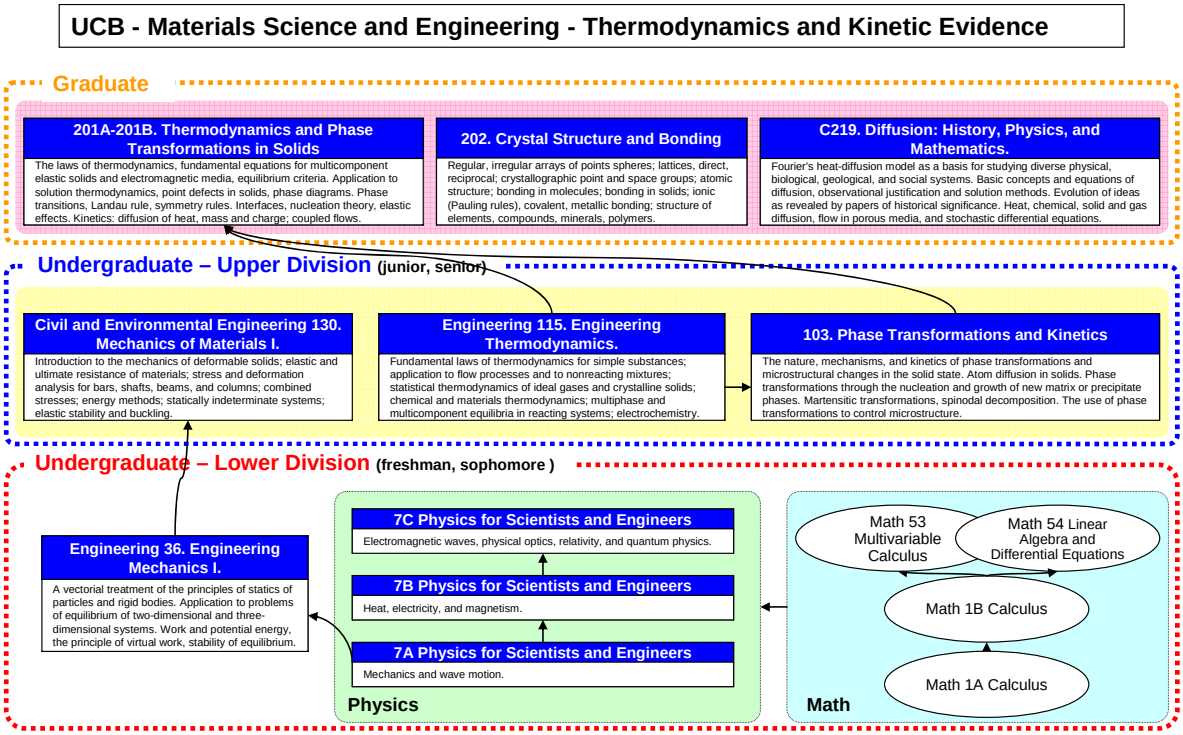
Structure of Subjects in Physics (Examples)
University of Cambridge

◎必修

	Enrollment Period	Course	Prerequisite subjects	Lecture courses	Requirement	Size of the Subject	Aim of Lecture	Contents of the Subject (Lecture Items)	Grading	Textbooks
						· Credits · Number of lectures	· Aim and Outline of the Lecture	· Structure of Lecture (at the headline syllabus level) · Major lecture items (laws, formulae, units, etc.)		
Undergraduate	Part IB (Second Year)	**Part IB Physics**	Part IA Physics and Part IA Mathematics	**CLASSICAL THERMODYNAMICS**	◎	N/A	1. to provide a continuing education in concepts in physics, which when combined with other courses will provide an illuminating survey of the natural sciences 2. to introduce new themes including the theory of waves and optics, quantum theory, the analysis of experimental data and classical thermodynamics 3. to continue to develop experimental skills and to gain experience of using modern instruments and experimental techniques	Introduction: Reminder of key IA material, including results from kinetic theory; partial differentiation. Fundamentals: Thermodynamic variables. Functions of state. Zeroth law; concept of temperature. Work and heat; First law of Thermodynamics. Heat capacities. The Second Law and Entropy: Reversible and irreversible changes. Clausius and Kelvin formulations of Second Law. Carnot's Theorem. Definition of thermodynamic temperature. Carnot cycle; heat engines, pumps and refrigerators; efficiency. Entropy and its increase. Entropy of ideal gas. Statistical interpretation of entropy. Analytical thermodynamics: Thermodynamic potentials and their uses. Introduction to Maxwell relations and their applications. Thermodynamics of radiation: Black body radiation; equation of state; Kirchoff and Stefan-Boltzmann laws. Real gases: Joule and Joule-Kelvin expansions. Van der Waals' equation. Boyle temperature; critical point; law of corresponding states. Phase changes: Conditions for equilibrium. Latent heat. Clausius-Clapeyron equation. Third law: Entropy at low temperatures; unattainability of absolute zero.	N/A	The following are particularly recommended: Equilibrium Thermodynamics Adkins C J (3rd edn CUP 1983). A good book at an appropriate level. Introductory Statistical Mechanics Bowley R and Sánchez M (OUP 1996). Recommended for the Statistical Physics course in IB Advanced Physics; the first few chapters useful for this course. Classical and Statistical Thermodynamics Carter AH (Prentice-Hall 2001). Another book useful for both this course and for Statistical Physics.
				QUANTUM PHYSICS	◎	N/A		The Failure of Classical Physics: Wave-Particle Duality and Uncertainty: The Schrödinger Equation: Unbound Particles: Bound Particles: Operator Methods: Quantum Mechanics in Three Dimensions: Spin and Identical Particles:	N/A	Books to consider buying: Quantum Physics, Gasiorowicz S (2nd edn Wiley 1996) A fine exposition of the subject, suitable for Part IB and Part II. Quantum Mechanics, Rae A I M (3rd edn Hilger 1992) A good, cheaper alternative to Gasiorowicz, much shorter and consequently less full in its treatment of difficult points. Quantum Mechanics, McMurry S M (Addison-Wesley 1993). Well suited to the course and including a disk with interactive illustrative programs. Quantum Mechanics Mandl F (Wiley 1992). Suitable for Part IB and Part II. Books for College libraries: Quantum Physics of Atoms, Molecules, Solids, Nuclei and Particles, Eisberg R and Resnick R (2nd edn Wiley 1985). Too elementary to recommend as a main textbook, but very good descriptive coverage of a wide range of quantum phenomena.
		Part IB Advanced Physics	Part IA Physics and Part IA Mathematics	**ELECTROMAGNETISM**	◎	N/A	1. to establish the first part of the core understanding of physics at a professional level. 2. to introduce new themes including more advanced classical mechanics, the general development of electromagnetism and statistical physics. 3. to provide an appropriate introduction to mathematical physics and the methods of theoretical physics, and to gain practice in using them. 4. to continue to develop experimental skills and to gain experience of using modern instruments and experimental techniques. 5. to provide a rigorous basis for experimental and theoretical physics at Part II level.	Introduction: Electrostatics: Magnetostatics: Faraday's law: Electromagnetic waves:	N/A	Electricity and Magnetism, Duffin W J (4th edn McGraw-Hill 1990). Start here if you find electromagnetism a mystery; the treatment is at about the right level for the course. Electromagnetism, Grant I S & Phillips W R (2nd edn Wiley 1990). This treatment is at about the level of the course. It is easier to read than Bleaney & Bleaney, but does not go so far. Physics (Volume 2), Halliday D, Resnick R, and Krane K S (5th edn Wiley 2002). This is fairly basic but is good for background and has interesting examples and pictures; it may also be useful for optics and quantum mechanics. Electricity and Magnetism, Bleaney B I & Bleaney B (3rd edn OUP 1989) (two volumes). This is a classic text that will see you through Part IB and Part II, but it is currently out of print.
				STATISTICAL PHYSICS	◎	N/A		Foundations of statistical physics: Applications to Physical Problems: Waves in a box: Condensed matter systems:	N/A	The following are particularly recommended and will also be found useful for the Part II course. Introductory Statistical Mechanics, Bowley R and Sanchez M (OUP 1996) Statistical Physics, Mandl F (2nd edn Wiley 1989) The Theory of Thermodynamics, Waldram J R (CUP 1987). Out of print but available in most College libraries. Other books are generally available in College libraries and may usefully be consulted. Fundamentals of Statistical and Thermal Physics, Reif F (McGraw-Hill 1965) Entropy and its Physical Meaning, Dugdale J S (Taylor & Francis 1996) For section on Condensed Matter see also: The Solid State, Rosenberg H M (3rd edn OUP 1988) Solid State Physics, Ashcroft N W and Mermin N D (Holt-Saunders 1976). The "student" edition is relatively cheap and will be useful for Part II Quantum Condensed Matter.
	Part II (Third Year)	**Part II Experimental & Theoretical Physics**	Part IB Physics and Part IB Advanced Physics	**THERMAL AND STATISTICAL PHYSICS**	◎	N/A	1. to establish the final part of the core understanding of physics at a professional level; 2. to introduce new themes including electrons in solids, a full development of statistical mechanics, more advanced quantum theory, more advanced electromagnetism with special relativity, atomic physics and modern optics, nuclear and particle physics, the theory of systems, and fluid mechanics; 3. to gain experience in a number of skills important to professional physicists; 4. for those taking Option A in particular, to broaden awareness of the breadth of the subject and its major applications, and to understand the importance of scientific communication and group working; and 5. to provide a sound basis in general physics, judged at the highest international standards.	Thermodynamics of simple systems: Further development of thermodynamics: Applications of thermodynamics: Statistical mechanics: Classical statistical mechanics: Quantum statistical mechanics: Ideal classical gas: Interacting systems and elementary excitations: Classical liquids: Fluctuations: Phase transitions:	N/A	Equilibrium Thermodynamics, Adkins C J (3rd edn CUP 1983). Covers most of the material on thermodynamics. Introductory Statistical Mechanics, Bowley R and Sanchez M (Oxford Science 1996). Covers most of the material on Statistical Physics.
				ADVANCED QUANTUM PHYSICS	◎	N/A		Review of Quantum Physics: Methods of Approximation: Relativity and Magnetic fields: Transitions: Atoms: Quantum information:	N/A	Quantum Physics, Gasiorowicz S (2nd edn Wiley 1996, 3rd edn Wiley 2003) Quantum Mechanics, Rae A I M (4th edn IoP 2002) Quantum Mechanics, Bransden B H and Joachain C J (2nd edn Pearson 2000) Molecular Quantum Mechanics, Atkins P W and Friedman R S (3rd edn OUP 1997) Problems in Quantum Mechanics, Squires G L (CUP 1995) Quantum Optics; An Introduction, Fox A M (OUP 2006)

C.3 材料工学

C.3.1 カリフォルニア大学バークレー校



UC Berkeley – Materials Science and Engineering
Undergraduate

Division	Year	Courses	分野	Requirement
Lower Division (freshman, sophomore)	Freshman	Mathematics 1A–1B. Calculus.	Core Program	◎
		Chemistry 1A–1B. General Chemistry.		◎
		Physics 7A. Physics for Scientists and Engineers.		◎
		24. Freshman Seminar.		
	Sophomore	Mathematics 53. Multivariable Calculus.	Core Program	◎
		Mathematics 54. Linear Algebra and Differential Equations.		◎
		Physics 7B–7C. Physics for Scientists and Engineers.		◎
		Engineering 36. Engineering Mechanics I.		◎
		Engineering 45. Properties of Materials.		◎
		Engineering 77. Introduction to Computer Programming for Scientists and Engineers.		◎
		84. Sophomore Seminar.		
Upper Division (junior, senior)	Junior	Engineering 115. Engineering Thermodynamics.	Core Program	◎
		Engineering 117. Methods of Engineering Analysis.		◎
		Civil and Environmental Engineering 130. Mechanics of Materials I.		◎
		102. Bonding, Crystallography, and Crystal Defects.		◎
		103. Phase Transformations and Kinetics.		◎
		111. Properties of Electronic Materials.		◎
		112. Corrosion (Chemical Properties).		◎
	Senior	100. Field Trips.	Core Program	◎
		104. Materials Characterization.		◎
		C113. Mechanical Behavior of Engineering Materials.		◎
		130A. Experimental Materials Science.		◎
		Chemical Engineering C178. Polymer Science and Technology.		◎
		120. Materials Production.		○
		121. Metals Processing.		
		122. Ceramic Processing.		
		123. Semiconductor Processing.		
		125. Thin-Film Materials Science.		
		117. Properties of Dielectric and Magnetic Materials		
		C118. Biological Performance of Materials.		
		C133. Microfabrication Equipment Laboratory.		
		H194. Honors Undergraduate Research.		
		195. Special Topics for Advanced Undergraduates.		
		198. Directed Group Study for Advanced Undergraduates.		
		199. Supervised Independent Study.		

◎:必修
○:選択必修

（注）
・Lower Divisionのコースには、全学部の学生を対象としたものも含まれる。
・Upper Divisionでは、Core Programに加えて、以下の5つのオプションの中の1つを 21unit（単位） 以上履修することが必要。
- Biomaterials
- Electronic Materials
- Materials Physics and Chemistry
- Structural Materials
- General

・上記の必修科目は、全オプションに共通する科目。これとは別に、オプションごとに必須科目、選択必修科目あり。

UC Berkeley – Materials Science and Engineering

Graduate(M.S., Ph.D., M.Eng., D.Eng.)

Year	Courses	分野	Master of Science Requirement
	201A. Thermodynamics and Phase Transformations in Solids	Core (Thermodynamics)	◎
	201B. Thermodynamics and Phase Transformations in Solids	Core (Structure or Phase Transformations)	○
	202. Crystal Structure and Bonding		
	215. Computational Materials Science		
	C219. Diffusion: History, Physics, and Mathematics		
	204. Theory of Electron Microscopy and X-Ray Diffraction	Core (Meterials Characterization)	○
	241. Electron Microscopy and Microanalysis Techniques		
	242. Advanced Characterization Techniques		
	205. Defects in Solids	Core (Materials Properties)	○
	206. Dislocations and Dislocation Plasticity		
	C211. Mechanics of Solids		
	C212. Deformation and Fracture of Engineering Materials		
	213. Environmental Effects on Materials Properties and Behavior		
	C214. Micromechanics		
	223. Semiconductor Materials		
	224. Magnetism and Magnetic Materials		
	260. Surface Properties of Materials		
	C216. Macromolecular Science in Biotechnology and Medicine	Core (Materials Processing)	○（または 223, 224, 121, 219）
	220. Rate Phenomena in the Synthesis and Processing of Materials		
	221. Fuel Cells, Batteries, and Chemical Sensors: Principles, Processes, Materials, and Technology		
	C225. Thin-Film Science and Technology		
	227. Solution Processing of Materials, Devices, and Nanostructures		
	200A. Survey of Materials Science		
	C226. Photovoltaic Materials; Modern Technologies in the Context of a Growing Renewable Energy Market		
	290A. Special Topics in Materials Science		
	298. Group Studies, Seminars, or Group Research		
	299. Individual Study or Research		
	601. Individual Study for Master's Students		
	602. Individual Study for Doctoral Students		
	300. Supervised Teaching of Materials Science and Engineering.		

○：選択必修

（注）

・学位の種類：学生は通常、Master of Science または Doctor of Philosophy degree を取得。

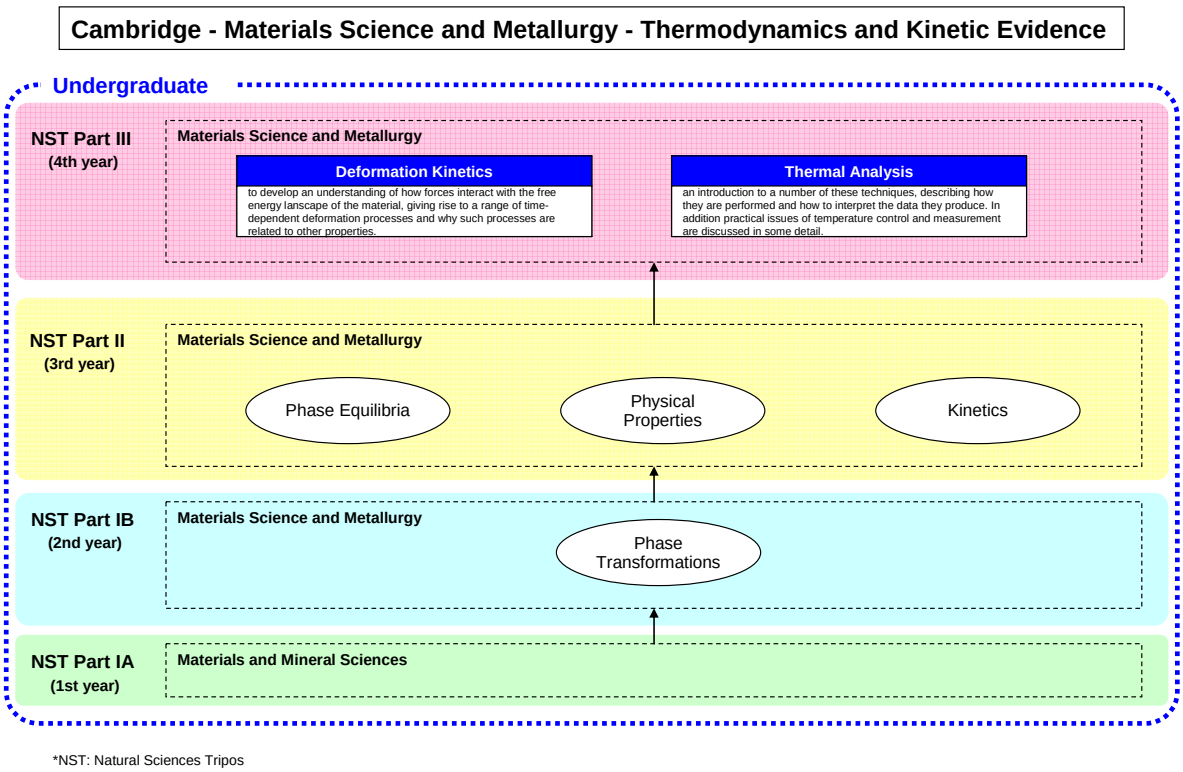
- M.S., Engineering
- M.S., Engineering Science
- Ph.D., Engineering
- Ph.D., Engineering Science
- Master of Engineering
- Doctor of Engineering

・上記の必修、選択必修科目は、Master of Scienceに関するもの。

University of California, Berkeley
Structure of Subjects in Materials Science and Engineering, Thermodynamics and Kinetic Evidence

	Enrollment Period		Subjects	Requirement	Size of the Subject	Prerequisite subjects	Aim of Lecture	Contents of the Subject (Lecture Items)	Grading	Textbooks
Undergraduate	Lower division (freshman, sophomore)	Freshman	**Physics 7A. Physics for Scientists and Engineers**	必修	4 credits. Three hours of lecture and four hours of laboratory/ workshop per week	High school physics; Math 1A or 1AS; Math 1B or 1BS	The students will learn the physics of the multiparticle system and the scattering problem based on the knowledge of quantum mechanics which has been learned.	Mechanics and wave motion See "Syllabus".	Grades will be determined from a weighting of all the elements of the course approximately as follows: - first midterm exam 20% - second midterm exam 20% - final exam 40% - homework 15% - laboratory/discussion/quizzes 5%	Required Texts: (1) D. C. Giancoli, Physics for Scientists and Engineers, Volume I, 4th edition. We will cover chapters 1 through 15, including most sections marked Optional. You will be expected to read those sections of the book relevant to a given lecture before class. (2) Birkett and Elby, Physics 7A Workbook is required for the Discussion/Lab sessions. The workbook consists of qualitative questions and quantitative problems that will help you gain mastery of the material. In addition, the workbook contains laboratory handouts which you will complete during the course's various labs.
		Sophomore	**Physics 7B. Physics for Scientists and Engineers**	必修	4 credits. Three hours of lecture and four hours of laboratory/ workshop per week	Physics 7A, Math 1A-1B,Math 53		Heat, electricity, and magnetism See "syllabus".	Exams and Grades: There will be two midterm examinations and a final exam. One problem on each exam will be taken directly from the homework assignments, and many of the other problems will be of similar form and difficulty as the homework problems. Dates and times are listed on the following page. For each midterm you will be allowed an equation sheet, whose size will be announced in the weeks leading up to the exams. A grade of "Incomplete" will only be given under dire circumstances beyond a student's control, and only when work already completed is of at least C quality. University guideline specifies that in lower division courses, the total percentage of students getting A and B should not exceed 65%. The good news is that 65% of the class will be getting A's and B's!	(1) D. C. Giancoli, Physics for Scientists and Engineers, Volumes I and II, 3rd edition. We will cover chapters 17 through 32, including most sections marked "Optional." You will be expected to read those sections of the book relevant to a given lecture before class. This is a required text. (2) 7B Workbook. This will be packaged with Giancoli in the campus bookstores. We will be using these workbooks in section. (3) Elby, Portable TA: Problem Solving Guide, Volume 1. This extremely popular resource contains practice problems about classical mechanics with completely worked out solutions. It is meant to be worked, not read. These practice problems are for your own benefit; we will not collect your work on them. We suggest working through at least some of the problems in Elby before attempting each week's homework assignment. This is a required text.
		Sophomore	**Physics 7C. Physics for Scientists and Engineers**	必修	4 credits. Three hours of lecture, one hour of discussion, and three hours of laboratory per week	Physics 7A-7B, Math 1A-1B, Math 53, 54		Electromagnetic waves, physical optics, relativity, and quantum physics	Weighting: Weekly Take-Home Quizes 5% Labs 10% Homework 10% First Midterm 20% Second Midterm 20% Final Exam 35%	- Giancoli, Physics for Scientists and Engineers, Custom Vol. 3 - Tipler and Llewellyn, Modern Physics, 4th edition - Physics 7C Lab Manual, available at Copy Central
		Sophomore	**Engineering 36. Engineering Mechanics I.**	必修	2 credits. Two hours of lecture per week.	Mathematics 1A-1B; Physics 7A.	N/A	A vectorial treatment of the principles of statics of particles and rigid bodies. Application to problems of equilibrium of two-dimensional and three-dimensional systems. Work and potential energy, the principle of virtual work, stability of equilibrium.	N/A	N/A
	Upper division (junior, senior)	Junior	**Engineering 115. Engineering Thermodynamics.**	必修	4 credits. Four hours of lecture per week.	Physics 7B, Math 54; Chemistry 1B recommended.	N/A	Fundamental laws of thermodynamics for simple substances; application to flow processes and to nonreacting mixtures; statistical thermodynamics of ideal gases and crystalline solids; chemical and materials thermodynamics; multiphase and multicomponent equilibria in reacting systems; electrochemistry. See "Course Descriptions".	ASSESSMENT OF STUDENT PROGRESS TOWARD COURSE OBJECTIVES - Approximately twenty-five to thirty problem sets each semester designed to provide immediate reinforcement and utilization of concepts presented in lecture. - Two 80-minute mid-term examinations - Final examination	Required text: D. R. Gaskell, Introduction to the Thermodynamics of Materials, 4th Edition (or 3rd Edition), Taylor and Francis.
		Junior	**Civil and Environmental Engineering 130. Mechanics of Materials I.**	必修	3 credits Three hours of lecture per week.	Civil and Environmental Engineering 60 or Engineering 45 and Engineering 36	N/A	Introduction to the mechanics of deformable solids; elastic and ultimate resistance of materials; stress and deformation analysis for bars, shafts, beams, and columns; combined stresses; energy methods; statically indeterminate systems; elastic stability and buckling.	N/A	N/A
		Junior	**103. Phase Transformations and Kinetics**	必修	3 credits. Three hours of lecture per week.	102 and Engineering 115.	N/A	The nature, mechanisms, and kinetics of phase transformations and microstructural changes in the solid state. Atom diffusion in solids. Phase transformations through the nucleation and growth of new matrix or precipitate phases. Martensitic transformations, spinodal decomposition. The use of phase transformations to control microstructure. See "Course Descriptions".	ASSESSMENT OF STUDENT PROGRESS TOWARD COURSE OBJECTIVES - Approximately twenty-five to thirty problem sets each semester designed to provide immediate reinforcement and utilization of concepts presented in lecture. - Two 80-minute mid-term examinations - Final examination	Required text: Porter and Easterling, Phase Transformations in Metals and Alloys, CRC Press
Graduate		N/A	**201A-201B. Thermodynamics and Phase Transformations in Solids**	必修	4 credit each. Four hours of lecture per week.	102, 103, Engineering 115, or consent of instructor. 201A is prerequisite to 201B.	N/A	The laws of thermodynamics, fundamental equations for multicomponent elastic solids and electromagnetic media, equilibrium criteria. Application to solution thermodynamics, point defects in solids, phase diagrams. Phase transitions, Landau rule, symmetry rules. Interfaces, nucleation theory, elastic effects. Kinetics: diffusion of heat, mass and charge; coupled flows.	N/A	N/A
		N/A	**202. Crystal Structure and Bonding**	選択必修	3 credits. Three hours of lecture per week.	None	N/A	Regular, irregular arrays of points spheres; lattices, direct, reciprocal; crystallographic point and space groups; atomic structure; bonding in molecules; bonding in solids; ionic (Pauling rules), covalent, metallic bonding; structure of elements, compounds, minerals, polymers.	N/A	N/A
		N/A	**C219. Diffusion: History, Physics, and Mathematics.**	選択必修	3 credits. Three hours of lecture per week.	Graduate standing in the sciences or engineering; consent of instructor.	N/A	Fourier's heat-diffusion model as a basis for studying diverse physical, biological, geological, and social systems. Basic concepts and equations of diffusion, observational justification and solution methods. Evolution of ideas as revealed by papers of historical significance. Heat, chemical, solid and gas diffusion, flow in porous media, and stochastic differential equations. Students to explore their individual interests in diffusion (experimental, theoretical, or historical) within a broader scientific context.	N/A	N/A

C.3.2　ケンブリッジ大学



*NST: Natural Sciences Tripos

University of Cambridge – Materials Science (Natural Sciences Tripos)
Undergraduate

Part (Year)	Courses	分野	Compulsory
Part IA (First Year)	Elementaray Mathematics for Biologists	Math	○
	Mathematics		
	Quantitative Biology		
	Materials and Mineral Sciences	Materials Science	◎
	Biology of Cells	Other subjects	○ (choose 2)
	Chemistry		
	Evolution and Behavior		
	Geology		
	Physics		
	Physiology of Organisms		
	Computer Science		
Part IB (Second Year)	Materials Science and Metallurgy	Materials Science	◎
	Animal Biology	Other subjects	○ (choose 2)
	Biochemistry and Molecular Biology		
	Cell and Developmental Biology		
	Chemistry A		
	Chemistry B		
	Ecology		
	Experimental Psychology		
	Geological Sciences A		
	Geological Sciences B		
	History & Philosophy of Science		
	Mathematics		
	Mineral Sciences		
	Neurobiology		
	Pathology		
	Pharmacology		
	Physics		
	Advanced Physics		
	Physiology		
	Plant and Microbial Sciences		
Part II Option A (Third Year)	Materials Science and Metallurgy	Materials Science	○
Part II Option B & Part III (3rd & 4th Year)	Materials Science and Metallurgy	Materials Science	

◎:必修
○:選択必修

(注)
・Natural Sciences Triposでは、1、2年次には幅広い分野を履修し、3年次に専門分野に特化する。
Part IA(First Year):数学1科目+3科目(7科目から選択)が必修
Part IB(Second Year):3科目(20科目から選択)が必修
→ここでは、3年次にMaterials Science and Metallurgyを選択する場合の前提履修科目についても◎としている。
・Natural Sciencesでは専門分野により修業年数が異なる。Materials Science and Metallurgyの場合は、3年コースと4年コースの2種類がある。
– 3年コースではB.A.degree、4年コースではB.A.degreeおよびM.Sci. degree (Master of Natural Sciences)が取得できる。

University of Cambridge – Materials Science
Undergraduate

Part (Year)	Course	区分	Lecture courses など	<Option A> Compulsory	<Option B>	Report など
Part IA (First Year)	Materials and Mineral Sciences	Lecture courses	Organisation of atoms in crystals	◎		
			Order and Disorder	◎		
			Materials and Devices	◎		
			Microstructure	◎		
			Mechanical Behaviour of Solids	◎		
			Biomaterials	◎		
			Materials under Extreme Conditions	◎		
Part IB (Second Year)	Materials Science and Metallurgy	Lecture courses	Phase Transformations	◎		
			Materials and the Environment	◎		
			Biomechanics – Materials & Structures	◎		
			Soft Materials	◎		
			Electronic Properties of Materials	◎		
Part II (Third Year)	Materials Science and Metallurgy	Lecture courses	Phase Equilibria	◎		
			Selection of Materials	◎		
			Mathematical Methods	◎		
			Tensor Properties	◎		
			Physical Properties	◎		
			Crystallography	◎		
			Kinetics	◎		
			Chemical Stability	◎		
			Alloys	◎		
			Structure & Properties of Polymers	◎		
			Surfaces & Interfaces	◎		
			Plasticity & Deformation Processing	◎		
			Ceramics	◎		
			Polymer Processing	◎		
			Fracture, Fatigue & Creep Deformation	◎		
			Composite Materials	◎		
			Heat & Mass Transfer	◎		
			Biomaterials	◎		
			Management Studies	◎		
		Practical and Project Work	Long Vacation Projects	◎	(対象外)	1 report
			Practicals & Materials Examination	◎		4 reports
			Design Project	◎		1 report
			Literature Survey	◎		1 survey
			Techniques Project	◎		1 report
			Management	◎	○	
			Language	(対象外)		
Part III (Final Year)	Materials Science and Metallurgy	Module lectures (1st Group)	Particle Technology	○ (choose 5)		
			Extraction and Recycling			
			Surface Engineering			
			Deformation Kinetics			
			Microfabrication and Nanotechnology			
			Biomaterials			
			Joining			
			Corrosion and Protection			
		Module lectures (2nd Group)	Electrons and Photons in Solids	○ (choose 5)		
			Polymeric Materials and Carbon Nanotubes			
			Electronic Ceramics			
			Glasses & Nanomaterials			
			Ionic Materials			
			Energy and Materials			
			Magnetic and Superconducting Materials			
			Materials Modelling			
		Techniques lectures	Thermal Analysis			
			Electron Microscopy & Analysis			
			Optical X-ray & Neutron Techniques			
			Industrial speakers and visits			
		Assessed work	Individual Research Project	◎		1 report
			Teamwork Research Project	◎		1 report
			Language	○		
			Management			
			Long vacation project report	◎		1 report

◎:必修
○:選択必修

(注)
・Natural Sciences Triposでは専門分野により修業年数が異なる。Physicsの場合は、3年コースと4年コースの2種類がある。
– 3年コースではB.A.degree、4年コースではB.A.degreeおよびM.Sci. degree (Master of Natural Sciences)が取得できる。
– Part II (Third Year) は、Option A(3年コース)、Option B(4年コース)に分かれる。
・lecturesの他にpracticals、supervisions(3名程度の少人数教育)などの履修が必須。

・Assessment(評価)
– Part IA(1年次): 試験(1 paper)、assessed practicals(4回)
– Part IB(2年次): 試験(2 papers)、assessed practicals(4回)、investigation of manufactured article (artefact)
– Part II(3年次): 試験(4 papers)、その他に数種類のreportなどの提出が必要。
– Part III(4年次): 試験(3 papers)、その他に数種類のreportなどの提出が必要。

・その他
– 夏季休暇中にIndustrial Project(企業での実習)、またはResearch Project が必須。
(3年コースの場合は、Part II に進級する直前、4年コースの場合は、Part II または Part III に進級する直前)

University of Cambridge – Materials Science and Metallurgy
Postgraduate (M.Phil., Eng.D., Ph.D.)

【MPhil Micro- and Nano-technology Enterprise】

	Module Name	Category	Assessment
NE.01	Characterisation Techniques	Science	E
NE.02	MEMS Design		C (design project + lab report +oral presentation)
NE.03	Materials and Processes for MEMS		C (essay + lab report)
NE.04	Nanofabrication Techniques		E + C (lab report)
NE.05	Nanomaterials		E
NE.06	Nanochemistry		E
NE.07	Physics at the Nanometre-Scale		E
NE.08	Bionanotechnology		E
MOT&I	Management of Technology and Innovation	Business management	C
T4 BBE	Building and Financing a new Enterprise		C
	Societal & Ethical Dimensions of Nano- and Biotechnology		C (report + oral presentation)
	Literature Survey / Patent Search	Project Part Ⅰ	C (report)
	Research/Business Project	Project Part Ⅱ	C (dissertation + viva+ oral presentation)

E: unseen written examination
C: coursework assessment (as specified)

(注)
・Department of Materials Science and Metallurgyでは、Graduate Coursesとして、次の2種類を提供している。
(1)MPhil Micro- and Nano-technology Enterprise (one year)
(2)Eng.D.:4年のプログラム。受入人数はわずか。
(3)Ph.D.
＊なお、MPhil in Materials and Modelling がacademic year 2006/07まで提供されていた。

【Ph.D.】
・1年目は、CPGS (Certificate of Post Graduate Study)に登録
・合格すると、このコースでさらに2年間勉強することが許可される。
- First Year
講義、セミナーへの出席
年度末に、short dissertation の提出と oral examination が必要

University of Cambridge
Structure of Subjects in Materials Science and Metallurgy, Thermodynamics and Kinetic Evidence

	Enrollment Period	Course	Prerequisite subjects	Lecture courses	Requirement	Size of the Subject	Aim of Lecture	Contents of the Subject (Lecture Items)	Grading	Textbooks
Undergraduate	Part IB (Second Year)	**Part IB Materials Science and Metallurgy**	Part IA Materials and Mineral Sciences	**Phase Transformations**	必修	12 lectures		Diffusion Solidification Solid-State Diffusional Transformations Diffusionless Solid-State Transformations Some Metallic Materials *See "SYNOPSIS"	N/A	Key Texts 1. H. K. D. H. Bhadeshia and R. W. K. Honeycombe, Steels, Microstructure & Properties, 3rd edition, Butterworths Heinemann, (2006) 2. A. Porter & K. E. Easterling, Phase Transformations in Metals and Alloys, 2nd edition Chapman & Hall, (1992)
	Part II (Third Year)	**Part II Materials Science and Metallurgy**	Part IB Materials Science and Metallurgy	**Phase Equilibria**	必修	6 lectures + 1 Examples Class		Laws of thermodynamics; equilibrium; reversibility; enthalpy, entropy and free energy Thermochemistry; variation of enthalpy, entropy and free energy changes for a reaction with temperature; equilibrium constant of a chemical reaction Thermodynamics of gases and condensed phase solutions; Roult's law, activity and activity coefficients; Henry's law and dilute solution; multicomponent solution and interaction coefficients; determination of activity Thermodynamics of mixing of solutions; Chemical potential; partial molar properties; Gibbs-Duhem equation; common tangent construction and equilibrium phase diagrams Case Studies: Application of thermodynamic concepts to (a) combustion reactions (b) gases in metals and (c-) aluminothermic reduction	N/A	Booklist JJ Moore, "Chemical Metallurgy" (Butterworth) DR Gaskell, "Introduction to Materials Thermodynamics" (McGraw-Hill)
				Physical Properties	必修	12 lectures + 1 Examples Class		Review of free electron theory Electrons in crystals: Zone scheme representations of E(k) Fermi surfaces for free and nearly-free electrons in two and three-dimensions. Cohesion in simple and transition metals Electron transport Theories of optical behaviour Band structure theory of absorption and reflection processes in materials Optical emission processes Introduction to magnetism Magnetic anisotropy The shape of the hysteresis loop	N/A	Booklist R.E. Hummel, Electronic Properties of Materials, (Springer-Verlag 1993) C. Kittel, Introduction to Solid State Physics, (Wiley 1986) D. Jiles, Electronic Properties of Materials, (Chapman and Hall 1993) N.W. Ashcroft and N.D. Mermin, Solid State Physics (Saunders College 1976)
				Kinetics	必修	9 lectures + 1 Examples Class		See "lectures courses handout"	N/A	Booklist Main reference – D. A. Porter and K. E. Easterling, Phase Transformations in Metals and Alloys
	Part III (Fourth Year)	**Part III Materials Science and Metallurgy**	Part II Materials Science and Metallurgy(Option B)	**Deformation Kinetics**	選択必修	12 lectures	The aim of this course is to develop an understanding of how forces interact with the free energy lanscape of the material, giving rise to a range of time-dependent deformation processes and why such processes are related to other properties.	See "Synopsis"	N/A	Reading list You might like to read chapter 2 of Deformation Mechanism Maps by Frost and Ashby gives a good overview of different deformation processes, including the lattice resistance. It provides a useful revision of what you have already covered. You should also read chapter 17, which is concerned with how materials fall into groups with similar properties. Another book to skim through is J.J. Gilman, Electronic Basis of the Strength of Materials. This covers elastic more than plastic behaviour, but you might like to read from Chapter 16 on, although chapter 15 is also interesting (and short). By far the best book on fracture is B.R. Lawn, Fracture in Brittle Solids.
				Thermal Analysis	選択	4 lectures	This course is an introduction to a number of these techniques, describing how they are performed and how to interpret the data they produce. In addition practical issues of temperature control and measurement are discussed in some detail.	1. An Introduction to Thermal Analysis — Definitions of Thermal Analysis (TA). Properties commonly studied by TA. Instruments available in the Department. Types of experimental scan. Reasons to use TA. 2. Differential Thermal Analysis — DTA apparatus. DTA scans. 3. Differential Scanning Calorimetry — Power-compensated DSC. Heat Flux DSC. Temperature Calibration. Measurement of latent heat, specific heat. 4. Other Techniques — Thermogravimetric analysis. Dynamic mechanical thermal analysis. Thin film DSC. Modulated DSC. 5. Examples of TA use — Kinetics of phase transformations. Materials science of chocolate. Polymer identification. 6. Practical Issues for Thermal Analysis — Temperature measurement. Furnace materials and control. Purge gases. Sample preparation. Examples Class. (Thursday 19th October)	N/A	Useful texts: M.E. Brown, Introduction to Thermal Analysis (Kluwer, 2001). R.F. Speyer, Thermal Analysis of Materials (Marcel Dekker Inc., 1994). T. Hatakeyama and F.X. Quinn, Thermal Analysis (Wiley, 1994).