Undergraduate Programme in Statistics

A. Introduction

Curriculum revision is a routine activity that must be undertaken by a Study Programme in order to develop quality, competitive excellence and conformity with market needs. This curriculum is a standard reference for the organization of Statistics Study Programme (UP-Stat) Universitas Gadjah Mada (UGM). In accordance with Presidential Regulation of Republic of Indonesia (RI) No. 8 year 2012 about Indonesian Qualifications Framework (IQF), UP-Stat curriculum has been formulated based on the graduate learning achievements which refer to IQF. Those learning achievements include 4 elements: Work Ability, Mastery of Knowledge, Managerial Capabilities, as well as Attitudes and Values.

B. Vision

To be an outstanding programme that is well recognised internationally and leading nationally in statistics education, produce competent graduates with high capability in their field, information technology literacy, entrepreneurial spirit and competitiveness both in national and international level around the year of 2025.

C. Missions

1. Develop the up-to-date learning process in order to increase its quality of the learning process.
2. Develop the quality and quantity of research and publication.
3. Increase the learning process and research cooperation between UP-Stat and its colleagues national as well as international.
4. Increase the education, research, training, and consultation services in statistics and its application.

D. Programme Educational Objectives (PEO)

After finish the study, students are:
1. able to master the theoretical concepts and methods of statistics and formulating them for problem solving;
2. able to develop statistics for the utilization and development of science and technology;
3. able to apply statistics on education, research and community services that benefit for the institution, community, nation and state;
4. able to make the right decisions based on analysis of statistics;
5. able to communicate scientific, cooperation as well as the responsibility of individuals and organizations.

Generic Description of Human Resource Qualification Level 6 of IQF for D-IV or undergraduate programme's graduates are those who are:

1. Capable to apply science, technology and art within her/his expertise and adaptable to various situations faced during solving a problem.
2. Mastering in-depth general and specific theoretical concepts of a certain knowledge and capable to formulate related problem solving procedure.
3. Capable to take strategic decision based on information and data analysis and provides direction in choosing several alternative solutions.
4. Responsible for her/his own job and can be assigned to take responsibility of the attainment of organization's performances.

Table 1. Relationship between PEO - IQF Level 6

	IQF 1	IQF 2	IQF 3	IQF 4
PEO 1	M	S		
PEO 2	S	S		
PEO 3	S	S		M
PEO 4			S	
PEO 5				S

S: strong   M:medium   L:light

E. Curriculum Objectives

1. Improve the appropriate learning process and evaluation system through Quality Assurance Cluster.
2. Increase utilization of Information Technology by students in order to improve the quality of graduates.
3. Provide an up-to-date and varied curriculum of UP-Stat to produce graduates who are able to work in various areas of statistical interest.
4. Increase popularity of UP-Stat in the community in order to get high quality student candidates.
5. Increase capacity of human resources and facilities in UP-Stat periodically.
6. Increase utilization of Information Technology for research and management of UP-Stat.
7. Establish networking with industry, community, and international world.

F. References for The Formulation of Curriculum 2016

In formulating curriculum, UP-Stat refers to
1. Ministerial Decree of Ministry of Research, Technology and Higher Education No. 44, 2015 about the national standard for higher education.
2. Law of the Republic of Indonesia number 12 year 2012 on Higher Education, article 35 about curriculum.
3. Document of "The Recommendation for The Minimal Curriculum for Undergraduate Programme in Statistics" which is published in 2012, in Malang, and in 2013, in Pontianak, by The Indonesian Statistical Society (Forstat), in which UP-Stat plays an important role in the document formulation.
4. The recommendations given by alumni and some stakeholders (user of the alumni) in a form of "Policy Study Document" (a result of survey by KJM and UP-Stat in 2012, "Alumni Meeting" in 2014 and 2015).
5. Document of the benchmarking resulted from
   a. BAN PT (http://ban-pt.kemdiknas.go.id/)
   b. Undergraduate programme in Statistics outside the country such as:
      1. Department of Statistics and Actuarial Sciences university of Waterloo, Canada
      2. Department of Statistics, University of Wisconsin
   c. Curriculum Guidelines for Undergraduate Programs in Statistical Science from American Statistical Association (ASA).

G. Graduates' Profession/ Employment

UP-Stat graduates' employment are as follows:
- Data Analyst on various fields
- Research Consultant
- Actuaries
- Research Manager
- Data Management
- Investment Manager

- Quality Control Manager
- Capital Market Analyst
- and many others.

H. Graduates' Profile
In general there are two major groups of graduates' profile in UP-Stat, namely:
1. Academician
   An academician is a highly educated person and work as a teacher or researcher at a college, university, or an institution of higher degree education
2. Statistical Practitioner
   A Statistical practitioner is an activist or person doing work using statistical methods.

I. Learning Achievement/ Graduates' Competence
By referring to the competence of IQF and Forstat, Vision, Missions and objectives, UP-Stat has formulated the Programme Learning Outcomes (PLO)

After the completion of the Bachelor's Degree Programme, students will:	
PLO-1	have strong basic statistics and mathematics in problem solving analysis
PLO-2	have statistical thinking and able to develop
PLO-3	have a good ability to utilize technology and statistical software in research
PLO-4	have experience in working on real cases in the field of statistics
PLO-5	have a good ability to communicate statistics in writing and oral
PLO-6	have ability to further studies, and or lifelong learning
PLO-7	have professional ethics, and soft skill

Based on the vision, mission, PEO, and the objectives described above, then the standard of graduates of UP-Stat have the following abilities:

A. Knowledge and understanding:
1. Have a strong basic statistical concept
2. Have knowledge to identify problems and determine the appropriate problem solving methods
3. Have knowledge of the development of Statistics in other related fields.

B. Intelectual (thinking) skills:
1. Able to think analytically, logically, in problem solving
2. Able to pursue a higher degree in related fields
3. Able to adapt to other science fields
4. Able to work independently, fully motivated and creative.

C. Practical skills:
1. Able to work in Statistical field
2. Proficient in various statistical techniques and numerical computations
3. Able to design and implement a statistical research.

D. Transferable skills:
1. Able to deliver ideas in statistical work
2. Able to deliver the results of statistical analysis by written or oral.

E. Attitude skills:
1. Devote to God Almighty and practicing Pancasila
2. Having an international perspective
3. Able to adapt to work environment
4. Have good professional ethics and soft skills.

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J. Field/ Studies Material

To support the achievement of the objectives of the study programme, the curriculum 2016 includes subjects:

1. Basic Mathematics:
   Calculus I, Calculus II, Linear Algebra for Statistics, Multivariable Calculus for Statistics, Elementary Differential Equations, Advanced Calculus.
2. Statistical Computation:
   Programming I, Programming I Laboratory, Statistical Computation I.
3. Basic Statistics:
   Statistical Methods I, Statistical Methods II, Exploratory Data Analysis, Survey Sampling Methods, Applied Regression Analysis, Introduction to Mathematical Statistics I, Introduction to Mathematical Statistics II, Introduction to Probability Models, Introduction to Sampling Theory, Introduction to Stochastic Processes, Introduction to Measurement and Probability Theory, Introduction to Time Series, Applied Multivariate Statistics, Introduction to Experimental Design, Introduction to Big Data, etc.
4. Application:
   Introduction to Financial Mathemathics I, Introduction to Financial Mathemathics II, Introduction to Actuarial Mathematics I, Introduction to Actuarial Mathematics II, Survival Data Analysis, Introduction to Queueing and Simulation Theory, Quantitative Risk Management, Introduction to Investment Management, Biostatistics and Epidemiology, Introduction to Decision Theory, Statistical Quality Control, etc.

K. Matrix mapping between courses and PLO

Course	PLO 1	PLO 2	PLO 3	PLO 4	PLO 5	PLO 6	PLO 7
Statistical Methods I	S		L	S	S	M	S
Calculus I	S					S	
Basic Physics I	S						
Basic Chemistry I	S						
Programming I	S		S				
Religious study							S
Pancasila State's Ideology							S
English					S		
Statistical Methods II	S		S				
Calculus II	S					S	
Exploratory Data Analysis	S		S	S			
Discrete Mathematics and Combinatorics	S						
Linear Algebra for Statistics	S					S	
Philosophy of Science and Professional Ethics Statistics				S			S
Survey Sampling Methods	S						
Multivariable Calculus for Statistics	S					S	
Elementary Differential Equations	S					S	
Introduction to Experimental Design	S	S			M		
Applied Regression Analysis	S	S	S	M	S	S	
Introduction to Mathematical Statistics I	S	S					
Introduction to Mathematical Statistics II	S	S					
Introduction to Probability Models	S	S					

Course	PLO 1	PLO 2	PLO 3	PLO 4	PLO 5	PLO 6	PLO 7
Advanced Calculus	S					S	
Introduction to Sampling Theory	S	M		S			
Statistical Computation I	S		S				
Applied Multivariate Statistics	S	S	S				
Introduction to Time Series	S	S	S				
Introduction to *Big Data*	S	S	S	S			
Introduction to Measurement and Probability Theory	S						
Official Statistics	S			S			
Citizenship							S
Internship			S	S	S		S
Seminar	S	S					
Introduction to Stochastic Processes	S						
Community Services	S						S
Final Project		S		M	S		

To realize the PLO, UP-Stat formulates curriculum consisted of courses which Course Outcomes (CO) support PLO.

L. Compulsory Courses

No	Code	Course	SKS	Prerequisite
Semester I				
1.	MMS-1404	Statistical Methods I	3(1)	
2.	MMM-1101	Calculus I	3	
3.	MFF-1011	Basic Physics I	3	
4.	MKK-1101	Basic Chemistry I	3	
5.	MII-1201	Programming I	3	
6.	MII-1202	Programming I Laboratory	1	
7.	UNU-100x	Religious study	2	
8.	UNU-1010	Pancasila State's Ideology	2	
			20	
Semester II				
1.	MMS-1409	Statistical Methods II	3(1)	MMS-1404*
2.	MMM-1102	Calculus II	3	MMM-1101*
3.	MMS-1410	Exploratory Data Analysis	3(1)	MMS-1404*
4.	MMS-1481	Discrete Mathematics and Combinatorics	2	
5.	MMS -1479	Linear Algebra for Statistics	3	
6.	MMS -1480	Philosophy of Science and Professional Ethics Statistics	2	
7.	MMM -1001	English	2	
			18	
Semester III				
1.	MMS -2481	Survey Sampling Methods	2	MMS-1404*
2.	MMS-2428	Multivariable Calculus for Statistics	2	MMM-1102*
3.	MMM-2301	Elementary Differential Equations	3	MMM-1102*
4.	MMS -2405	Introduction to Experimental Design	3	MMS-1409*
5.	MMS -2421	Applied Regression Analysis	3(1)	MMS-1409*
6.	MMS -2420	Introduction to Mathematical Statistics I	3	MMM-1102*

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7.	MMS-2410	Introduction to Probability Models	3	MMM-1102*
			19	
Semester IV				
1.	MMS -2483	Introduction to Mathematical Statistics II	3	MMS-2420*
2.	MMM-2111	Advanced Calculus	2	MMM-1102*
3.	MMS-2485	Introduction to Sampling Theory	2	MMS 2481*
4.	MMS-2422	Statistical Computation I	3(1)	
			10	
Semester V				
1.	MMS-3421	Applied Multivariate Statistics	3(1)	MMS-2420*
2.	MMS-3429	Introduction to Time Series	3(1)	MMS-2420*
3.	MMS-3404	Introduction to Measurement and Probability Theory	3	MMM-1102*
4.	MMM-3002	Introduction to Stochastic Processes	3	MMS-2410*
5.	MMS-3489	Internship	2	100 SKS
			14	
Semester VI				
1.	MMS-3488	Official Statistics	2	
2.	UNU-3000	Citizenship	2	60 SKS, IPK>2
4.	MMS-3437	Seminar	1	100 SKS
3.	MMS-3487	Introduction to Big Data	2	MMS-3421*
			7	
Semester VII				
1.	UNU-4500	Community Development Participation/Community services	3	100 SKS
			3	
Semester VIII				
1.	MMS-4099	Final Project	6	110 SKS
			6	
		Total credit of compulsory courses	**97**	

Note :
1. SKS n(1) means n credits for lecture and 1 credit for laboratory work.
2. Final Project is held in each semester.
3. Final Project duration is set to be 2 semester.
4. Seminar becomes a prerequisite of Final Project defense.
5. Students who have TOEFL score at least 500 will get grade A automatically.
6. Codes for Religious course:
    UNU-1000: Islam
    UNU-1001: Catholic
    UNU-1002: Christian
    UNU-1003: Hindu
    UNU-1004: Buddha
    UNU-1005: Confucius

M. Elective Courses

No	Code	Course	SKS	Prerequisite
Semester III				
1	MMS-2418	Introduction to Financial Mathemathics I	3	MMM-1101*
2	MMS-2492	Introduction to Insurance Accounting I	3	
3	MMS-2493	Introduction to Microeconomics	3	
			9	
Semester IV				
1.	MMS-2424	Applied Analysis of Variance	3(1)	MMS-1409*
2.	MMS-2415	Demography	3	MMS-1404*
3.	MMS-2425	Statistical Quality Control	3(1)	MMS-1404*
4.	MMS-2419	Introduction to Financial Mathemathics II	3	MMS-2418*
5.	MMS-2426	Categorical Data Analysis	3(1)	MMS-1409*
6.	MMS-2496	Introduction to Insurance Accounting II	3	MMS-2492*
7.	MMS-2497	Introduction to Macroeconomics	3	MMS-2493*
8.	MMS-2427	Forecasting Methods	3(1)	MMS-1409*
			24	
Semester V				
1.	MMS-3438	Introduction to Actuarial Mathematics I	3(1)	MMS-2418*
2.	MMS-3439	Introduction to Queueing and Simulation Theory	3(1)	MMS-2410*
3.	MMS-3424	Quantitative Risk Management	3	MMS-2420*
4.	MMS-3441	Biostatistics and Epidemiology	4(1)	MMS-1409*
5.	MMS-3442	Statistical Computation II	3(1)	MMS-2422*
6.	MMS-3432	Introduction to Actuarial Risk Theory I	3	
			19	
Semester VI				
1.	MMS-3431	Nonparametric Statistical Method	3	MMS-1409*
2.	MMS-3477	Introduction to Actuarial Mathematics II	3	MMS-3438*
3.	MMS-3443	Survival Data Analysis	3(1)	MMS-1409*
4.	MMS-3433	Introduction to Investment Management	3	MMS-2418*
5.	MMS-3434	Introduction to Actuarial Risk Theory II	3	MMS-3432*
6.	MMS-3435	Structural Equation Modelling	3	MMS-3421*
7.	MMS-3445	Introduction to Econometrics	3(1)	MMS-1409*
			21	
Semester VII				
1.	MMS-4415	Introduction to Response Surface	3	MMS-1409*
2.	MMS-4449	Capita Selecta in Statistics A	3	MMS-2483*
3.	MMS-4416	Introduction to Panel Data Analysis	3	MMS-2420*
4.	MMS-4421	Introduction to Decision Theory	3	MMS-1404*
5.	MMS-4422	Introduction to Pension Fund Valuation	3	MMS-3438*
			15	
Semester VIII				
1.	MMS-4402	Reliability	3	MMS-2420*
2.	MMS-4494	Spatio-Temporal Modelling	3	MMS-3429*
3.	MMS-4403	Sequential Methods	3	MMS-1409*
4.	MMS-4423	Capita Selecta in Statistics B	3	
			12	
	Total credit of elective courses		**100**	

* : has been taken

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For students from year intake 2016, the total required credits needed to graduate from UP-Stat is at least 144 SKS with 97 SKS of compulsory courses and at least 47 SKS of elective courses.

Elective Course of Stream
Information:
1. Elective courses of stream are courses directed to be taken by the students completely on a certain stream.
2. Elective course of stream can be taken by students from other study programs.
3. Students are directed to determine at least one stream in the early of the second year.
4. Final Project topic must correspond to one of the stream (the stream which all elective courses have been taken).

i. Actuarial Science Stream

Actuarial science is the discipline that applies mathematical and statistical methods to assess risk insurance, finance, and other industries. Actuarial science can be seen as a mixed discipline of probability theory, mathematics, statistics, finance, economics, and computing. A professional who has expertise in actuarial science called actuary. Usually actuaries unite in a professional association. In Indonesia, we have Persatuan Aktuaris Indonesia (PAI-Society of Actuaries of Indonesia). To be an actuary, a candidate has to pass various exams. They devided into two levels of them: Associate of Society of Actuaries of Indonesia (ASAI) and Fellow of Society of Actuaries of Indonesia (FSAI). To be accredited in ASAI level, a candidate should pass financial mathematics (A10), probability and statistics (A20), economics, accountancy, statistical method, actuarial mathematics, risk theory and modeling exams. All of them have been arranged to the exemption programme in our undergraduate degree programme. For those who passed certain courses in our curriculum with certain minimal mark they are elligible to get an exemption for PAI subject exam. Graduate of this stream may work in insurance company, pension plan, department of finance, OJK, etc. The following are the courses for actuarial science stream:

No	Course
1	Introduction to Financial Mathemathics I
2	Introduction to Financial Mathemathics II
3	Introduction to Actuarial Mathematics I
4	Introduction to Actuarial Mathematics II
5	Survival Data Analysis

ii. Biostatistics stream

Biostatistics is application of statistics in various topics in biological sciences (health sciences, medicine, pharmacy, biology and agriculture). Biostatistics studies about experimental design, especially in health and agriculture. Professions in biostatistics are much needed in such areas as: Research Institute, Educational Institution, Drug and Pharmaceutical Industry, Government Institution in health or hospital, Consultant and others. Here are 10 SKS of elective courses in Biostatistics stream.

No	Course
1	Categorical Data Analysis
2	Biostatistics and Epidemiology
3	Survival Data Analysis

iii. Business and Industrial Stream

Statistics is very important for business and industry because it helps decision makers in a company in the monitoring process, prediction, estimation, and decision making. The use of Statistics will reduce the risks of errors, both systemic and natural risks, in decision making. Bachelor of Statistics from business and industrial stream are able to work in banking, service and goods companies, agribusiness and mining companies, government departments, and others. Here are 15 SKS of elective courses in Business and Industrial stream.

No	Course
1	Statistical Quality Control
2	Categorical Data Analysis
3	Applied Analysis of Variance
4	Introduction to Decision Theory
5	Introduction to Big Data

iv. Finance Stream

Finance stream are designed for students who have particular interest in statistical modeling for finance. In this stream, various topics about finance are studied included pricing, hedging, portfolio, and risk assessment of financial products, both deterministic and stochastic. Graduates from finance stream will have ability to apply statistics in solving finance industry problems. They are also encouraged to develop computation and communication skills. They may work in financial sector and government institution such as: Banking, Financial consulting company, Department of Finance, and others. Here are 12 SKS of elective courses in finance stream.

No	Course
1	Introduction to Financial Mathemathics I
2	Introduction to Financial Mathemathics II
3	Quantitative Risk Management
4	Introduction to Investment Management

N. General Rules, Transitions, and Course Equivalence

In the transition periods, we have rules and equivalence of courses as the following:

1. Lab work course in 2011 curriculum and before will be implanted in the course where they belong to before in the 2016 curriculum. Those courses still have lab works but we don't separate the course and its lab work course. The activity of lab work will be done as it should be, and its mark will be a component of the total mark of the course.
2. The mandatory course in the previous curriculum that are not shown in current curriculum (2016) can be considered as compulsory courses.
3. For courses that move from odd/even semester, we will offer them in each semester in 2016/2017.
4. Students of UP-Stats are not allowed to take some courses that are equivalence, such as Professional ethics in computer science and professional ethics in chemistry, etc. If so they can be considered as just one course.
5. If students take the compulsory course that require prerequisite course(s) then they have to also include those prerequisite course(s) in their intention to graduate (yudisium).

Example 1: A student got C for Introduction to Mathematical Finance I and got A for Introduction to Mathematical Finance II. If this student will include the Introduction to Mathematical Finance II in his/her intention to graduate then he/she should also include that Introduction to Mathematical Finance I.

Example 2: Someone got A in the Introduction to Mathematical Finance I and C for the Introduction to Mathematical Finance II, he/she may include only that Introduction to Mathematical Finance I in his/her intention to graduate form and cancel the Introduction to Mathematical Finance II.

6. Things that have not been shown in this rule, will be decided in the Study Program level.
7. Students of 2015 and before can follow the following transitions:

Equivalency between Curriculum 2011 and Curriculum 2016

Previous Name		New Name	
Code	Course	Code	Course
MMS-2403	Survey Sampling Methods (3 sks)	MMS-2481	Survey Sampling Methods (2 sks)
MMS-3427	Research Methodology	MMS-3488	Official Statistics
MMM-1202	Elementary Linear Algebra	MMS-1479	Linear Algebra for Statistics
MMS-1408	Discrete Mathematics and Combinatorics (3 sks)	MMS-1481	Discrete Mathematics and Combinatorics (2 sks)
MMM-2109	Multivariable Calculus I	MMS-2428	Multivariable Calculus for Statistics
MMS-3474	Biostatistics and Epidemiology I	MMS-3441	Biostatistics and Epidemiology
MMS-3494	Biostatistics and Epidemiology I Laboratory		
MMS-3475	Biostatistics and Epidemiology II		
MMS-1423	Statistical Methods I	MMS-1404	Statistical Methods I
MMS-1453	Statistical Methods I Laboratory		
MMS-1425	Statistical Methods II	MMS-1409	Statistical Methods II
MMS-1455	Statistical Methods II Laboratory		
MMS-3469	Introduction to Mathematical Statistics II	MMS-2483	Introduction to Mathematical Statistics II
MMS-1406	Exploratory Data Analysis	MMS-1410	Exploratory Data Analysis
MMS-1456	Exploratory Data Analysis Laboratory		
MMS-2423	Statistical Quality Control	MMS-2425	Statistical Quality Control
MMS-2453	Praktikum Statistical Quality Control		
MMS-3402	Applied Regression Analysis	MMS-2421	Applied Regression Analysis
MMS-3452	Applied Regression Analysis Laboratory		
MMS-3472	Introduction to Actuarial Mathematics I	MMS-3438	Introduction to Actuarial Mathematics I
MMS-3492	Introduction to Actuarial Mathematics I Laboratory		
MMS-3473	Survival Data Analysis	MMS-3443	Survival Data Analysis
MMS-3493	Survival Data Analysis Laboratory		
MMS-3471	Introduction to Time Series	MMS-3429	Introduction to Time Series
MMS-3451	Introduction to Time Series Laboratory		
MMS-3417	Applied Analysis of Variance	MMS-2424	Applied Analysis of Variance
MMS 3457	Applied Analysis of Variance Laboratory		
MMS-1000	English	MMM-1001	English
MMS-3415	Statistical Computation	MMS-2422	Statistical Computation I
MMS-3455	Statistical Computation Laboratory		
MMS-3422	Introduction to Stochastic Processes	MMM-3002	Introduction to Stochastic Processes
MMS-4401	Internship	MMS-3489	Internship

Previous Name		New Name	
Code	**Course**	**Code**	**Course**
MMS-2455	Categorical Data Analysis	MMS-2426	Categorical Data Analysis
MMS-2495	Categorical Data Analysis Laboratory		
MMS-3430	Forecasting Time Series Data	MMS-2427	Forecasting Methods
MMS-3450	Forecasting Time Series Data Laboratory		
MMS-3416	Introduction to Queueing and Simulation Theory	MMS-3439	Introduction to Queueing and Simulation Theory
MMS-3456	Introduction to Queueing and Simulation Theory Laboratory		
MMS-4409	Introduction to Econometrics	MMS-3445	Introduction to Econometrics
MMS-4459	Introduction to Econometrics Laboratory		
MMS-3476	Introduction to Decision Theory	MMS-4421	Introduction to Decision Theory

Cooperation between UGM and PAI

Several courses in UP-Stat can be used to get ASAI level in PAI's exam topic certifications as listed below (with certain prerequirement):

PAI's Exam Topic	UP-Stat's Course
A.10. Financial Mathematics	Introduction to Financial Mathemathics I
	Introduction to Financial Mathemathics II
A.20. Pobability and Mathematical Statistics	Introduction to Mathematical Statistics I
	Introduction to Mathematical Statistics II
A.30. Accounting	Introduction to Insurance Accounting I
	Introduction to Insurance Accounting II
A.40. Economics	Introduction to Microeconomics
	Introduction to Macroeconomics
A.50. Statistical Methods	Applied Regression Analysis
	Survival Data Analysis
	Introduction to Time Series
A.60. Actuarial Mathematics	Introduction to Actuarial Mathematics I
	Introduction to Actuarial Mathematics II
A.70. Modeling and Risk Theory	Introduction to Actuarial Risk Theory I
	Introduction to Actuarial Risk Theory II

The process of submitting PAI certification is done collectively through the Administration of Mathematics Department. Further information about this cooperation can be obtained from Mathematics Department. Terms of grade for certification are as follows:
a. Starting in 2016, the equivalence of an exam topic of PAI with two or three courses in UGM, must meet the average grade of > 3.5.
b. Students who had passed the course before the curriculum 2016 applied, should follow the old rules.

Comparison between Curriculum 2011 and 2016

Curriculum 2016 of UP-Stat attemps to overcome the weaknesses of curriculum 2011 by the following methods:
a. incorporation of laboratory credit (in curriculum 2011) with its theoretical courses based on these considerations:
  1. separation of laboratory credit from theory credits, they must be taken together conditionally, gives difficulty to UGM academic information system (SIA) because

there are students who take advantage from the weakness of SIA by only taking theory credits
2. very high/good laboratory grades are considerably different from theory grades which are relatively normal
b. holding comprehensive course
c. completion of PAI actuarial courses which are equivalent to PAI's exam topics.

O. Learning Method

To achieve the formulated graduates' competence, students of UP-Stat are given teaching centered learning method for basic and theoretical courses and student centered learning method for applied and computational courses, included:
1. the lecture system is based on the philosophy of cognitivism, connectionism, behaviorism, and constructivism
2. several abilities are developed during the lectures, such as: presentation, writing scientific papers, cooperative, collaborative, creative, and innovative
3. IT based activities, bilingual (English - Indonesia) delivery, and cross fertilization principle are included in the lectures
4. lectures practice character education (discipline, responsibility, honest, meticulous, tenacious, never give up).

P. Assessment Method

Assessment consists of two forms: process assessment and product assessment. Process assessment is done observasionally by lecturers in the classroom included skills, participation, presentation, and attitude of students during the lecture activity. Product assessment consists of written or oral exam results, and work assignments. Each assessment aspect has its own weight.

Syllabus

Calculus I

The course will cover about the system of real numbers, functions and their graph, the limit of a function, continuity, the derivative, the geometric interpretation of the derivative, higher-order derivatives, the Mean Value Theorem, L'Hospital's rule theorem of extreme value, applications of extreme problem, increasing and decreasing functions, concavity, inflection points, sketching the graph of functions, Taylor and MacLaurin series.

References :
1. Mizrahi, A. and Sullivan, M., 1990, *Calculus and Analytic Geometry,* Wadsworth.
2. Stewart, J., 1999, *Calculus,* 4th edition, Brooks/Cole Pub. Comp.
3. Adam, R.A. and Essex, C., 2010, *Calculus, A Complete Course*, Pearson.
4. Tim Pengajar Kalkulus, *Diktat Kuliah Kalkulus I,* FMIPA UGM.

Exploratory Data Analysis

Exploratory analysis: type of data, data presentation, stem and leaf plot, boxplot, numerical summary, standardization, transformation, random sample, sampling distribution. Confirmatory analysis: one batch, comparison of batches, one way analysis of variance. Exploratory and confirmatory regression analysis, categorical data analysis, elementary analysis, two way analysis of variance.
Introduction to statistical software. Minitab or SPSS for data: stem and leaf plot, numerical summary, boxplot, transformation; random sampling; Confirmatory analysis:

z-test, t-test, one way analysis of variance, exploratory regression analysis, simple regression analysis, categorical data analysis.

References :
1. Tukey, J.W., 1977, *Exploratory Data Analysis*, Addison Wesley.
2. Kitchens, L.J., 2003, *Basic Statistics and Data Analysis*, Thomson.
3. Ott, R.L.,1993, *An Introduction to Statistical Methods and Data Analysis*, 4th edition, Duxbury Press, London.

Statistical Methods I

Descriptive statistics : data collection, data presentation. Measures of central tendency, dispersion, elementary probability, random variables and their distributions, sampling distribution. The Binomial, Hypergeometric, Poisson and Normal distributions. Statistical inference: estimation and test of hypotheses for one and two populations for mean, proportion, and variance.

References :
1. Gunardi et al., 2004, *Metode Statistika*, FMIPA UGM.
2. Mc. Kabe, 1990, *Introduction to the Practical Use of Statistics* , John Wiley and Sons.
3. Triola, M.F., 2004, *Elementary Statistics*, Adison Welley.
4. Bhattacharya, G. K., and Johnson, R. A., 1997, *Statistical Concept and Methods*, John Wiley and Sons, New York.
5. Moore, David S. and McCabe, G., 1998, *Introduction to The Practice of Statistics,* W.H. Freeman and Company, New York.
6. Walpole, R.E., and Myers, R.H., 1995, *Ilmu Peluang dan Statistika untuk Insinyur dan Ilmuwan*, 4th edition**,** ITB Bandung.
7. Good, P.I., 2005, *Introduction to Statistics Through Resampling Methods and Microsoft Office Excel*, Wiley – Interscience, John Wiley & Sons, Inc., Hoboken, New Jersey.
8. Deborah, R., 2006, *Probability for Dummies*, Wiley Publishing, Inc., Indianapolis, Indiana.
9. Suhov, Y., and Kelbert, M., 2005, *Probability and Statistics by Example*, Cambridge University.

Statistical Methods II

One way ANOVA, multiple comparison analysis (MCA), two way ANOVA, linear regression, correlation, multiple linear regression, contingency tables: independence and homogeneity, Fisher's exact test, introduction nonparametric statistics: sign test, wilcoxon signed rank test for matched pairs, friedman test, wilcoxon rank-sum test for two independent samples, kruskal-wallis test, rank correlation, run test for randomness. Application of SPSS and other statistical software for: Goodness of fit test for normal distribution, Categorical Data Analysis, one way and two way ANOVA, homogenity of variance test, regression analysis, nonparametric statistics test.

References :
1. Abdurakhman, 2005, *Handout Metode Statistika II*. FMIPA UGM.
2. Triola, M.F., 2004, *Elementary Statistics*, Adison Welley.

Calculus II

Indefinite integral: definition, properties, methods. The Definite integral: definition, properties, The Fundamental Theorem of Calculus, Change of Variable in a Definite

Integral, Improper integrals. Applications of Integration: area, volume of solids of revolution, arc length, surface area of a solid of revolution, center of mass, Pappus-Guldin's Theorem, moment of inertia.

References:
1. Mizrahi, A. and Sullivan, M., 1990, *Calculus and Analytic Geometry,* Wadsworth.
2. Stewart, J., 1999, *Calculus,* 4th edition, Brooks/Cole Pub. Comp.
3. Adam, R. A. and Essex, C., 2010, *Calculus, A Complete Course*, Pearson.
4. Tim Pengajar Kalkulus, *Diktat Kuliah Kalkulus II,* FMIPA UGM.

Matematika Diskrit dan Kombinatorik

Mathematical proof: Mathematical Induction, Contradiction, Tables of Truth, Logical Deduction. Set Theory: Finite and Infinite Set, Set Operation, Inclusion and Exclusion Principles, Double Set. Predicate Logic: Universal and Existential Quartifiers. Discrete Probability: Permutation, Combination, Discrete Probability, Conditional Probability, Independence, Information. Relation and Functions: Binary relation, properties of binary relation, equivalence relation, Partial ordered relation, Scheduling task problem, injective, surjective and bijective functions, Differential Equations (Recurrences): 1st order, 2nd order, and k^{th} order autonomous linear differential equations. Introduction to Graph Theory: Directed and non-directed Graph, Shortest Trajectory on weighted graph.

References:
1. Grimaldi, R., 1998, *Discrete and Combinatorial Mathematics An Applied Introduction*, 4th edition, ISBN 0201199122 , Addison-Wesley Longman.
2. Liu, C.L., 1995, *Elements of Discrete Mathematics*, translation editin, Mc Graw Hill.

Linear Algebra for Statistics

System of linear equation, Matrices and matrix operation, Inverse matrices, Determinants, Linear independence, basis and dimension, Eigenvalues and eigenvectors, Quadratic forms and positive definite matrices, Rank and canonical forms, Generalized inverse, Vector of differential operators, Application in Statistics, Matrix algebra of regression analysis.

References:
1. Anton, H., and Rorres, C., 2005, *Elementary Linear Algebra*, 9th edition, John Wiley & Sons, New Jersey.
2. Schott, J. R., 1997, *Matrix Analysis for Statistics*, John Wiley & Sons, Canada.
3. Searle, S. R., 2006, *Matrix Algebra Useful for Statistics*, John Wiley & Sons, Canada.

English

Grammar, Speaking, Reading, Writing and Presentation.

References :
1. http://www.englisch-hilfen.de
2. Longman Preparation Course for the TOEFL Score
3. Barrons iBT preparation
4. Azar, B.S., 2002, *Understanding an Using English Grammar*, 3rd edition, Longman Pub. Group, Pearson Education, New York.
5. Azar, B.S., 2003, *Fundamental of English Grammar*, 3rd edition, Longman Pub. Group, Pearson Education, New York.

6. Hult, C.A. and Huckin, T.N., 2001, *The New Century Handbook*, 2nd edition, Longman Pub. Group,Pearson Education, New York.

Survey Sampling Methods

Sample and population; data frame; sampling unit; sample survey design: objectives and phases, sample size; observational and experimental studies; probability sampling; non-probability sampling; sampling instrument design; data cleaning, coding, table and chart, data processing and analysis, data dissemination.

References :
1. Warwick, W.P. and Lininger, C.A., 1975, *The Sample Survey:Theory and Practice*, McGraw-Hill, Inc., New York.
2. Buckingham, A. and Saunders, P., 2004, *The Survey Methods Workbook*, Oddisey Press Inc., New Hampsire.
3. Scheaffer, R.L., Mendenhall, W., and Ott Lyman, 1990, *Elementary Survey Sampling*, 4th edition, PWS-Kent Publishing Company, Boston.

Elementary Differential Equation

a. Introduction:
   i. Motivation of emergence of differential equations from real life problems.
   ii. Definition of differential equations and their solutions.
b. First order differential equations: separable equations, homogeneous equations, exact equations and integrating factors, linear equations, Bernoulli's differential equation.
c. Higher order linear differential equations: Reduction of order, nonhomogeneous differential equations and their method of solutions-the method of undetermined coefficients, the method of variation of parameters-, the method of differential operators (optional), Cauchy-Euler equations.
d. Series solutions.
e. Systems of differential equations and their methods of solution.
f. Laplace transform and its applications for solving differential equations and systems of differential equations.
g. Simple applications of differential equations.

References
1. Ross, S.L., 1984, *Differential Equations*, J. Wiley, New York.
2. Boyce, W.E. and DiPrima, R.C., 1992, *Elementary Differential Equations and Boundary Value Problems*, J.Wiley, New York.
3. Borelli, R.L. and Coleman, C.S., 1996, *Differential Equations: A modeling perspective, Preliminary Edition*, John Wiley & Sons, New York.

Introduction to Experimental Design

Principles of experimental design, complete random design, complete random block desiagn, factorial design, latin square design, split plot design, nested design.

References:
1. Montgomery, D. C., 2004, *Design and Analysis of Experiments*, John Wiley & Sons. New York.
2. Steel, R.G.D., Torrie, J.H. and Dickey, D.A., 1997, *Principles and Procedures of Statistics A Biomedical Approach*, McGraw-Hill, New York.
3. Box and Hunter, 1978, *Statistics for Experimenters*, John Willey.

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Applied Regression Analysis

Simple linear regression and correlation, multiple linear regression, categorical independent variables, choice of the best model, and residual analysis.

References:
1. Montgomery, D. C. and Peck, E.A., 2006, *Introduction to Linear Regression Analysis*, John Wiley & Sons, New York.
2. Myer, R.H., 1997, *Classical and Modern Regression with Applications*, PWS-KENT, Boston.
3. Drapper, N.R. and Smith H, 1998, *Applied Regression Analysis*, John Wiley & Sons.
4. Dielman, Terry, E., 2001, *Applied Regression Analysis for Bussiness and Economics*, Duxbury Press, New York.
5. Mendenhall., W. and Sincich., T., 1996, *A Second Coursein Statistics: Regression Analysis*, Prentice Hall, New Jersey.

Introduction to Mathematical Statistics I

Probability space; Probability and Conditional Probability, Random Variables; Independence; Distributions: Binomial, Poisson, Hypergeometric, Normal, Log Normal, t-Student, Exponential, Cauchy, Weibull, F, Chi-square, etc.; Moment Generating Function, Likelihood function.

References :
1. Bain, L.J. and Engelhardt, 1992, *Introduction to Probability and Mathematical Statistics*, Duxbury Press.
2. Rice, J. A., 1995, *Mathematical Statistics and Data Analysis*, Duxbury Press.
3. Wackerly, D. D., Mendenhall, W., and Scheaffer, R. L., 2002, *Mathematical Statistics with Applications*, Duxbury Press.

Introduction to Sampling Theory

Probability sampling, estimation of a population mean, total and proportion for various sampling technique.

References :
1. Jessen, R. J., 1978, *Statistical Survey Techniques*, John Wiley and Sons.
2. Cochran, W.G., 1977, *Sampling Techniques*, 3rd edition, John Wiley and Sons.

Introduction to Probability Models

Sample space and event, Probability, Conditional Probability, Independence, Random Variable, Expectation, Mean and Variance, Moment Generating Function, Jointly distributed random variable, Independent random variable, Conariance and variance of sum of random variable, Contitional mean and conditional variance, Limit theorem, Stochasic processes, Markov chain, Chapman-Kolmogorof equation

References :
1. Ross, S.M., 1997, *Introduction to Probability Models, sixth edition,* Academic Press.
2. Bain, L.J. and Engelhardt, 1992, *Introduction to Probability and Mathematical Statistics*, Duxbury Press.
3. Hogg, R.V. and Craig, A.T., 1978, *Introduction to Mathematical statistics,* Macmillan Publishing Co., Inc.

Introduction to Mathematical Statistics II

Sampling distribution; Point estimation: estimation and its properties, MME, MLE; Hypothesis testing: Neyman-Pearson Lemma, uniformly strongest test, likelihood ratio test; Interval estimation: introduction to nonparametric estimation such as Bootstrap etc.

References:
1. Rice, J. A., 1995, *Mathematical Statistics and Data Analysis*, Duxbury Press.
2. Wackerly, D. D., Mendenhall, W., and Scheaffer, R. L., 2002, *Mathematical Statistics with Applications*, Duxbury Press.

Advanced Calculus

Series: definition, algebra operation, convergence, series with positive terms, convergence tests, radius of convergence, absolute convergence and conditional convergence, alternating series, rearrangement of series terms. Riemann integral: partition, length of partition, upper and lower Riemann integral, Riemann integral and its properties, Darboux integral, primitive of Riemann integrable function and its properties, integral as upper bound function. Gamma and Beta functions.

References :
1. Taylor, A.E., 1989, *Advanced Calculus*, Blaisdell.
2. Bartle, R.G. and Sherbert, D.R., 2011, *Introduction to Real Analysis*, 4th edition, John Wiley and Sons.
3. Parzynski, W.R. and Zipse, P.W., 1982, *Intruduction to Mathematical Analysis*, McGraw-Hill Book Company, New York.

Applied Multivariate Statistics

Set up multivariate data, matrix of mean, matrix covariance, multivariate normal distribution the formula and properties, estimator of the parameters, the testing hypothesis one and several population mean and covariance, the principal component, factor analysis, discriminant analysis, multivariate regression

References :
1. Johnson, R.A, and Winchern, D.W., 1982, *Applied Multivarite Statistical Analysis*, John Wiley & Sons.
2. Hardle, W., and Simar, L., 2003, *Applied Multivariate Statistical Analysis*, Springer.
3. Hair, J.F, Anderson, R.E., Tatham, R.L., and Black, W.G., 1995, *Multivariate Data Analysis with Reading*, 4th edition, New Jersey : Prentice-Hall.
4. Rencher, A.C., 2002, *Methods of Multivariate Analysis*, Brigham Young University.

Introduction to Time Series

Topics include basic concepts, such as: Stochastic process, the auto covariance and the auto correlation function (ACF), the partial ACF (PACF), strictly and wide-sense stationary, causality and invertibility; Estimating the mean, ACF and PACF; Some stationary models (White noise, Moving Average/MA, Autoregressive/AR, ARMA), Estimation and forecasting stationary models, Diagnostic check methods, some non stationary model: ARIMA, SARIMA, ARIMAX and ARCH/GARCH, Short overview of the other models.

References:
1. Wei, W.S., 1990, *Time Series Analysis : Univariate and Multivariate Methods*, Addison-Wesley.

2. Brockwell, P.J. and Davis, R.A., 1996, *Introduction to Time Series and Forecasting*, Springer Verlag, Berlin.
3. Cryer, J.D., 1986, *Time Series Analysis,* Duxbury, London.
4. Makridakis, S., Wheelwright, S.C., and McGee, V.E., 1983, *Forecasting Methods and Applications,* Wiley, New York.
5. Yaffee, R.A., and McGee, M., 2000, *Introduction to Time Series Analysis and Forecasting,* Academic Press, New York.
6. Rosadi., D., 2004, *Panduan Praktikum Pengantar Runtun Waktu*, FMIPA UGM.
7. Enders, W., 2004, *Aplied Econometric Time Series*, Wiley.
8. Gourieroux, C., 1997, *ARCH Models and Financial Applications*, Springer-Verlag.

Introduction to Measurement and Probability Theory

Algebra of sets, fundamental concept of probability theory, measure and probability, random variable and its distributions, convergence concepts, relation between convergence, central limit theorem and its application.

References:

1. Tsokus, M., 1985, *Introduction to real analysis and probability*.
2. Haeussler, E. F., Paul, R. S., and Wood, R., 2005, *Introductory Mathematical Analysis*, Pearson Education Inc.

Introduction to Stochastic Processes

Stochastic Processes and Random Processes; Random Walk; Markov Chains, Transition Probabilities, Chapman-Kolmogorov Equation; Classification of States and Chains, Limiting Probabilities; Poisson Processes, Birth and Death Processes, Continuous Time Markov-Chains; Simulation and Computation.

References:

1. Hoel, P.G., Port, S.C. and C.J. Stone, 1972, *Introduction to Stochastic Processes.* Houghton Mifflin Company.
2. Jensen, P.A. and J.F. Bard, 2003, *Operation Research: Models and Methods*, John Wiley & Son.
3. Ross, S. M., 1996, *Stochastic Processes,* 2nd editon, John Wiley & Sons Inc.
4. Ross, S. M., 2010, *Introduction to Probability Models,* 10th edition, California, Academic Press.
5. Russell, S. J. and Norvig, P., 2003, *Artificial Intelligence; a Modern. Approach*, 2nd edition, Prentice Hall, New Jersey.

Official Statistics

Population indicatirs: Total population, Population density, Population by age, Life expectancy at birth and at age 65, Foreign born, Foreigners in population, Total fertility rate, Infant mortality; employment category: Employment rate, Unemployment rate, Youth unemployment rate, Economic activity rate (women and men), Employment in major sectors: agriculture, industry, services, sources of data for statistics : Statistical survey or sample survey, census, register, Official Statistics presentation.

Introduction to Financial Mathemathics I

Measurement of interest rate, solving interest rate problem, basic annuity, advanced annuity, yield rates.

References:
1. Kellison, S. G., 1991, *The Theory of Interest*, John Wiley & Sons, New York.
2. Yuh-Dauh Lyuu, 2004, *Financial Engineering and Computation*, Cambridge University Press, United Kingdom.

Introduction to Financial Mathemathics II

Amortization schedule, Sinking funds, payment period, securities, bond, and practical application.

References:
3. Kellison, S. G., 1991, *The Theory of Interest*, John Wiley & Sons, New York.
4. Yuh-Dauh Lyuu, 2004, *Financial Engineering and Computation*, Cambridge University Press, United Kingdom.

Applied Analysis of Variance

One way Anova: model 1 (fixed effect) and model II (random effect). Topics in Analysis of Variance such as multiple comparison by Tukey, Scheffe, Bonferoni methods, Two Way Anova: Model I (fixed effect), model II (random effect), model III (mixed effect). Multi Way Anova: Model I (fixed effect), model II (random effect), model III (mixed effect). One Way and Two Way Analysis of Covariance (Anacova).
Application of SPSS and other statistical software for hypothesis testing in comparison of several population means using analysis of variance.

References :
Neter, J.W., Kutner, M.H., Nachtsheim, C.J., and Wasserman, W., 2005, Applied Linear Statistical Models, McGraw Hill.

Introduction to Actuarial Risk Theory I

Introduction: random variables, basic distributional quantities, tails of distribution, measures of risk; Characteristic of actuarial model; Creating new distributions; Selected distributions and their relationship; Discrete distributions; Frequency and severity with coverage modifications; Aggregate loss models.

References:
Klugman, S. A., Panjer, H. H., and Willmot G. E., 2012, *Loss Model: From Data to Decision*, 4th edition, Wiley.

Introduction to Actuarial Risk Theory II

Review on mathematical statistics; Estimation for complete data; Estimation for modified data; Frequentis estimation; Bayesian estimation; Model selection; Credibility theory.

References:
Klugman, S. A., Panjer, H. H., and Willmot G. E., 2012, *Loss Model: From Data to Decision*, 4th edition, Wiley.

Demography

Basic concepts in Demography. Statistical techniques and models for demographic analysis. Mortality models and life table. Population dynamics.

References:
1. Rowland, T., 2003, *Demographic Methods and Concepts*, Oxford University Press.
2. Mantra, I.B., 2007, *Demografi Umum*, 2nd edition, Pustaka Pelajar.

Statistical Quality Control

Modeling process quality, statistical process control, control charts for attributes, control charts for variables, other statistical control techniques, process capability analysis, acceptance sampling for attributes and acceptance sampling by variables, statistical software for quality control.

References:
1. Montgomery, D.C., 2009, *Introduction to Statistical Quality Control*, John Wiley and Sons.
2. Wadsworth, H.M., 2002, *Modern Methods for Quality Control and Improvement*.

Categorical Data Analysis

Two-way contingency tables, goodness-of-fit test, types of study design, measures of association, simple and multiple logistic regression, and model-building strategies.
Introduction to SPSS and other statistical software for data analysis with categorical response variable, 2x2 and *bxk* contingency tables and their association measures, research design: Cross sectional, retrospective, and prospective, logit and loglinear models, emphasizing in the application.

References:
1. Agresti, A., 2002, *Categorical Data Analysis*, John Wiley & Sons, New York.
2. Daniel, W.W., 1987, *Biostatistics, a Foundation for Analysis in the Health Sciences*, 4th edition, John Wiley &Sons, New York.
3. Fleiss, J.L., 1981, *Statistical Methods for Rates and Proportions*, John Wiley & Sons, New York.
4. Hosmer, D.W. and Lemeshow, S., 1989, *Applied Logistic Regression*, John Wiley & Sons. New York.

Introduction to Queueing and Simulation Theory

Basic concept of probability theory, Basic concept of stochastic process and Markov chain, Birth-death process, Poisson process, Queueing system: M/M/1, G/M/1, M/G/1, G/G/1, Priority queues, Queueing network, Simulation model.
Application of statistical software to decice or create simple queueing model, birth and death model, queueing network, simulation model.

References:
1. Bunday, B.D., 1996, *An Introduction to Queueing Theory*, Arnold.
2. Law, A.M. and Kelton, W.D, 1991, *Simulation Modeling and analysis*, 1991, McGraw-Hill, Inc.

Quantitative Risk Management

Introduction to Risk Management Theory: VaR and Risk Metrics. Mathematical Concepts: Matrices, Linear and Cubic Interpolations, Complex Numbers. Numerical Methods: Newton-Raphson, Secant Methods, Numerical Methods for ntegration of Single and Dual Dimensions Probability Theory Concepts: Parameter, Variance-

Covariance Matrix, PCA, univariate and multivariate distributions, joint distributions, mgf, CLT, MLE. Monte Carlo Methods: Random numbers, Variance Reduction. Single asset VaR: Parametric (Normal and Non-Normal), Non Parametric, Monte Carlo methods, VaR for portfolio of Assets.

References:
1. Dowd, K., 1998, *Beyond Value at Risk*, Wiley, Chichester.
2. Jorion, P., 2001, *Value at Risk*, McGraw-Hill, New York.
3. Rupert, D., 2004, *Statistics and Finance, An Introduction*, Springer, New York.
4. Holton, G.A., 2003, *Value-at-Risk, Theory and Practice*, Academic Press, Amsterdam.

Biostatistics and Epidemiology

Study Design in Epidemiology (observational, *cross-sectional*, *follow-up*, *case-control* research), Statistics and measures in Epidemiology (*risk-difference*, risk ratio,OR, rate), Confounding and interaction, Logistic regression, Diagnostic test, Poisson regression, Groups comparison for survival data, Advanced design (*case-cohort*, *nested case-control*, *clinical trial*, *cross-over trial*), Generalized Linear Model, Longidinal data analysis, Conditional logistic regression, Regression for survival data, Biostatistical Consulting, Advanced Topics.

References :
1. Danardono, 2007, *Bahan Ajar Biostatistika dan Epidemiologi*, Jurusan Matematika, FMIPA UGM.
2. Le, Chap T, 2003, *Introductory Biostatistics*, Wiley.
3. Clayton, D. and Hills, M., 1993, *Statistical Models in Epidemiology*, Oxford University Press.
4. Kleinbaum, D.G., Kupper, L. L., and Morgenstern, H., 1982, *Epidemiologic Research*, Lifetime Learning Pub.Wadsworth, Inc.

Nonparametric Statistical Method

Elementary properties of ordered statistics and joint distribution. Run test and goodness-of-fit test, one sample Kolmogorov-Smirnov test. One sample and paired sample test. Two sample Wilcoxon-Mann-Whitney test, Wald-Wolfowitz run test, general linear rank test. Scale parameter comparison test. Simple procedures for interval estimation based on rank statistics.

References :
Conover, W.J., 1999, *Practical Non-parametric Statistics*, John Wiley and Sons.

Introduction to Actuarial Mathematics I

Modelling Life Insurance based on stochastic approach. During the course session, the students may learn the operation of Life Insurance companies. Several technical and actuarial procedures are given to understand the calculation and detemination of such actuarial quantities like premium and benefit reserves.
Application of Table Manager from SOA to determine mortality rate. Determination of annuity and premium using R or MS Excel.

References:
1. Bowers, et.al, 1997, *Actuarial Mathematics*, 2nd edition, Society of Actuaries.
2. Effendie, A.R, 2005, *Modul Praktikum Asuransi Jiwa 2*.

Introduction to Actuarial Mathematics II
Discrete and continuous premium, Reserve, Multiple life, Multiple decrements.

References:
Bowers, et.al, *Actuarial Mathematics*, 1997, 2nd edition, Society of Actuaries.

Survival Data Analysis
Survival data (duration data, time-to-event data), type of survival data: censored and truncated sample, survival distribution model, parametric inference for survival data, Kaplan-Meier, Life-Table, Nelson-Aalen, parametric regression and Cox regression for survival data.

References :
Elsayed, E.A., 1996, *Reliability Engineering*, Addison Wesley Longman, Inc.

Introduction to Investment Management
Introduction to investment and types of return; General random variable for return of portfolio; Simple methods of portfolio : Mean-variance and CAPM; Trading portfolio and analysis of performance; Option : European and American, Call and Put; Volatility, Black Scholes (BS) and Binomial model; Performance analysis of BS in Market.

References:
1. *An Introduction to Financial option Valuation, Mathematics, Stochastics and Computation,* 2nd edition, Cambridge University Press, 2004.
2. Hull, J.C., 2005, *Options, Futures, and Other Derivatives*, 6th edition, Prentice Hall.

Structural Equation Modelling
Regression analysis, Principle Component Analysis, Exploratory and confirmatory factor analysis, Path analysis, Structural equation model with intermediatery latent variable (first order), and Structural equation model without intermediatery latent variable (second order): Measurement and structural models, parameter estimation: maximum likelihood. Chi-square model goodness-of-fit test, model power measurement CFI, GFI, AGFI. Least error measurement, fitness index. Data analysis using AMOS software.

References:
1. Abdurakhman, 2005, *Handout Mata kuliah*.
2. Hair, J.F., Black, W.C., Babin, B.J., Rolph, E., Anderson, and Tatham, R.L., 2006, *Multivariate Data Analysis*, 5th edition, Pearson Education International.Inc., New Jersey.
3. Johnson, R.A. and Wichern, D.W., 2002, *Applied Multivariate Statistical Analysis,* 5th edition, Pearson Education International.

Introduction to Econometrics
Classical linear regression model, The method of Ordinary Least Squares (OLS) assumptions, OLS estimators, Properties of OLS estimators, Autocorrelation, Heteroscedasticity, Multicollinearity, application.

References :
Judge, G.E., et al., 1982, *Introduction to the Theory and Practice of Econometric*, John Wiley & Sons.

Introduction to Panel Data Analysis

Review of concepts from probability theory, OLS and GLS Estimation methods for linear models, Linear Panel Models: Fixed-Effect and Random Effects one and two ways, Estimation methods, Poolability test, Hausman Specification Test, Breush Pagan Test, Selection and Validating Models, Overview for advanced models, Computation and Application.

References:
1. Baltagi, B.H., 2001, *Econometric analysis of Panel Data*, Wiley.
2. Greene, W.H., 2000, *Econometric Analysis*, 4th edition, 2000, Prentice Hall
3. Hsiao, C. H., 2005, *Analysis of Panel Data*, 2nd edition, Cambridge University Press.

Introduction to Decision Theory

Principles for decision analysis, Subjective probability and utility theory, States of nature, strategi for decision making, Bayesian decision function.

References :
Raiffa, H. and Schlafer, N., 1970, *Applied Statistical Decision Theory Division of Research Graduate School of Bussiness*, Harvard University.

Introduction to Pension Fund Valuation

Introduction, Pension Fund Policy in Indonesia, Pension Funding Principles, Legal Basis, Objective and function of Pension Fund, Type of Pension Fund Management Institution, Pension Fund Mechanism for Financial Institution, Annuity, Survival Distribution, Death Acceleration, Full Life Expectancy, Pension Benefit, Design of Pension Fund, Notation and terminology, Individual Cost Method, Traditional Unit Credit, Benefit with Salary Scale, Projected Unit Credit, Defined Benefit vs. Defined Contribution, Aggregate Cost Method, Actuarial Liability, Past Service Liability.

References:
1. Aitken, W.H., 1996, *A Problem-Solving Approach to Pension Funding and Valuation*, ACTEX publication.
2. Winklevoss, H.E., 1993, *Pension Mathematics with Numerical Illustrations*, Univ. of Pennsylvania Press.
3. Bowers, et.al., 1997, *Actuarial Mathematics*, 2nd edition, Society of Actuaries.

Reliability

Empirical reliability measurement. Reliability function, hazard function. Reliability distribution models: Poisson process and exponential distribution, Gamma distribution, Weibull distribution, Lognormal distribution. Multicomponent system: serial, parallel, complex. Minimal path and minimal cut. Reliability boundaries. Bridge case. Star and delta configuration, Delta to star configuration, star to delta configuration. Reliability allocation. Redundancy.

References :
1. Grosh, D.L, 1989, *A Primer of Reliability Theory*, John Wiley & Sons.
2. Elsayed A. Elsayed, 1996, *Reliability Engineering*, Addison Wesley Longman, Inc.