RTU Course "Supplementary Mathematics (Aviation Transport)"

31000 Faculty of Civil and Mechanical Engineering

General data

Code	BM0549
Course title	Supplementary Mathematics (Aviation Transport)
Course status in the programme	Compulsory/Courses of Limited Choice
Responsible instructor	Emma Šidlovska
Academic staff	Vitālijs Pavelko
Volume of the course: parts and credits points	1 part, 6.0 credits
Language of instruction	LV, EN
Annotation	The study course provides knowledge of ordinary and partial differential equations of mathematical methods, Fourier analysis, vector analysis and field theory, probability theory and mathematical statistics as well as application of mathematical models of damage and failure accumulation in aircraft operation modeling and aircraft safety analysis and aerosol analysis for successful mastering of aerohydromechanics.
Goals and objectives of the course in terms of competences and skills	The aim of the study course is to promote the in-depth acquisition of knowledge in solving the problems of aircraft aerodynamics, aerohydromechanics and safety analysis by applying mathematical knowledge. The tasks of the study course are to teach: - the application of calculations of differential equations for the study of mechanical and electrical systems; - scalar field gradient and vector field divergence and rotor calculation; - the Fourier method in solving partial differential equations; - mathematics and physics tasks in modelling aircraft operation; - mathematical models of damage accumulation; - probability theory, damage and refusal to calculate probability.
Structure and tasks of independent studies	Work with literature and the Internet. Independent solving of mathematical problems (homework).
Recommended literature	Obligātā/Obligatory: 1. Pavelko I. Aerohidromehānika/Lekciju konspekts. Rīga: RTU, 2009. - 94 lpp. 2. Pavelko V. Gaisakuģu aerodinamika/Mācību līdzeklis. Rīga: RTU, 2009. - 258 lpp. 3. Paramonov Yu. M. Aeroplane structure and strength analysis. Riga: RTU, 2009. 4. Paramonovs Ju.M., Paramonova A. Ju. Transporta līdzekļu slodzes, resurss un drošums. Rīga: RTU, 2002. - 108 lpp. 5. Volodko I. Augstākā matemātika, 2. daļa. Rīga: Zvaigzne ABC, 2009. - 396 lpp. 6. Koliškins A. Augstākā matemātika, 3. daļa. Varbūtību teorija un matemātiskā statistika. Rīga: Zvaigzne ABC, 2011. - 88 lpp. 7. Pavļenko O., Šadurskis K. Varbūtību teorija un matemātiskā statistika: lekciju konspekts. Rīga: RTU, 2011. 8. Pavļenko O., Šadurskis K. Varbūtību teorija un matemātiskā statistika: praktiskie darbi. Rīga: RTU, 2011. 9. Šteiners K. Augstākā matemātika, Lekciju konspekts inženierzinātņu un dabaszinātņu studentiem, IV, V un VI daļa. Rīga: Zvaigzne ABC, 1999 - 2001. 10. Salenieks N. Mehānisko un tehnoloģisko sistēmu drošums. Rīga: RTU MKI, 1994. - 33 lpp. Papildu/Additional: 11. Urbahs A., Carjova K., Urbaha M., Stelpa I. Gaisa kuģu konstrukciju nesagraujošā kontrole. Rīga: RTU, 2017. - 310 lpp. 12. Tikhonov A.N., Samarskii A.A. Equations of mathematical physics. Dover Publications, 2013. 13. Smotrovs J. Varbūtību teorija un matemātiskā statistika. Rīga: Zvaigzne ABC, 2004. 14. Krastiņš O. Varbūtību teorija un matemātiskā statistika. Rīga: Zvaigzne, 1985. 15. Андронов А.М., Копытов Е.А., Гринглаз Л.Я. Теория вероятностей и математическая статистика [Учебник для вузов]. Москва [и др.] : Питер, 2004. - 460 с. 16. Филиппов А.Ф. Сборник задач по дифференциальным уравнениям. Москва: Интеграл-Пресс, 1998. - 208 с. 17. Тихонов А.Н., Самарский А.А. Уравнения математической физики. Москва: Изд-во МГУ, 1999. 18. Gertsbakh I.B. Reliability theory with application to preventive maintenance. Berlin, NY, London, Tokio: Springer, 2000. - 218 p. 19. Swift T. Damage tolerance Technology.
Course prerequisites	Higher mathematics, physics, technical mechanics.

Course contents

Content	Full- and part-time intramural studies		Part time extramural studies	
	Contact Hours	Indep. work	Contact Hours	Indep. work
Research of periodic processes. Fourier protrusion in real and complex form. Fourier transform. Signal spectral projection.	8	6	0	0
Process research with first order differential equations. Reactive motion, Tsiolkovsky formula. Transition processes in electrical circuits.	4	4	0	0

Investigation of processes using second and higher order linear differential equations with constant coefficients. Special oscillations in mechanical and electrical systems. Forced oscillations. Reson	6	4	0	0
Scalar and vector fields in physics, aerodynamics and hydrodynamics. Gradients, divergence, rotor. Continuity equation.	4	4	0	0
Modeling of aerodynamic and hydrodynamic processes. Modeling of aviation engine thermal and thermodynamic processes. Corresponding equations and problems of mathematical physics. Variable Separation.	8	4	0	0
Probabilities of damage and refusal. Classical definition of probability. Basic concepts of probability theory.	4	4	0	0
Sum and multiplication of events. Sum of incompatible events. Multiplication of independent events.	4	4	0	0
Conditional probability. Multiplication of events and sum probabilities in the general case. Full probability formula.	4	4	0	0
Beiesa formula. Application of full probability and Beies formulas in damage and rejection analysis. Bernoulli rehearsal scheme. Binomial distribution. Poisson distribution. Poisson's flow of events.	4	4	0	0
Bernoulli rehearsal scheme. Binomial distribution. Poisson distribution. Poisson's flow of events.	4	4	0	0
Discrete and continuous random variables. Statistical definition of probability. Probability density.	4	4	0	0
Mathematical hope and variance. Average distance and average time to failure.	4	4	0	0
Distribution functions. Moda. Median. Central moments. Asymmetry factor. Excess.	4	4	0	0
Even distribution. Exponential distribution. Normal distribution. Weibull distribution.	4	4	0	0
Mathematical models of damage and failure accumulation. Durability distribution functions. Basics of reliability theory.	4	4	0	0
Numerical solution of first order differential equations and study of solution stability. Laboratory work. Mathcad (Matlab).	2	4	0	0
Investigation of the equation of oscillations in the modes of special oscillations and forced oscillations. Laboratory work. Mathcad (Matlab).	4	4	0	0
Working with discrete distributions. Laboratory work. MS Excel.	2	5	0	0
Verification of the compliance of the continuous random variable with the normal and exponential distributions. Laboratory work. MS Excel.	2	5	0	0
Total:	80	80	0	0

Learning outcomes and assessment

Learning outcomes	Assessment methods
Is able to study the transition processes in mechanical and electrical systems, as well as to analyze the special oscillations and forced oscillations of the systems using 1st order differential equations and higher order linear differential equations with constant coefficients.	Laboratory works. Homework.
Able to solve simple mathematical physics problems with partial differential equations, which arise in modeling aircraft operation.	Homework. Tests. Testing.
Able to calculate the probabilities of events using the classical definition of probability, theorems on the sum and multiplication of events, full probability formula, Beies formula.	Homework. Tests. Testing.
Can work with discrete and continuous distributions and can calculate mode, median, mathematical expectation, variance, standard deviation, asymmetry factor and excess.	Laboratory works. Homework.
Able to apply mathematical methods in aircraft operation modeling and aircraft safety analysis.	Exam.

Evaluation criteria of study results

Criterion	%
Laboratory works	15
Tests	20
Calculations (homework)	30
Testing	5
Exam	30
Total:	100

Study subject structure

Part	CP	Hours			Tests		
		Lectures	Practical	Lab.	Test	Exam	Work
1.	6.0	30.0	40.0	10.0		*	