"Approved"
Head of the department
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"____"_____2015

QUESTIONS AND TYPICAL PROBLEMS FOR THE ENTRANCE EXAMINATION

List of questions on the discipline "Optimal Control Systems"

1. Describe two types of synthesis of systems. Explain the penalty function technique for synthesis of continuous and discrete systems.
2. Describe the parametric synthesis procedure (synthesis of PID-controller).
3. State the problem of system optimization. Describe the optimization problem solving technique with the help of computer software.
4. Explain the application of penalty function in the complex performance index.
5. Explain the Nelder-Mead method of optimization.
6. Explain Pontryagin's maximum principle.
7. Explain the conception of time-optimal control.
8. Explain the synthesis procedure of optimal control systems in frequency domain. Write down the performance index for stochastic systems.
9. Explain the synthesis procedure of optimal control systems in frequency domain. Describe application of the Wiener-Kolmogorov theory in this synthesis procedure.
10. Write down and explain the Wiener-Hopf equation in frequency domain and the expression for transfer function of optimal stochastic controller.
11. State the problem of analytical design of optimal controller for deterministic continuous systems. Describe the application of Riccati equation for the problem solution and conditions for existence of optimal controller.
12. State the problem of analytical design of optimal controller for deterministic discrete systems. Describe the application of Riccati equation for the problem solution and conditions for existence of optimal controller.
13. Describe the procedure of optimal controller design for continuous and discrete systems with the help of computer software.
14. Explain the conception of reduced order observers and application of Luenberger filter for incomplete measurement systems.
15. Explain the conception of stochastic dynamic system observer. Describe the application of Kalman filter for stochastic dynamic systems. (Continuous case).
16. Describe the procedure of Kalman filter design with the help of computer software. (Continuous case).
17. Describe the procedure of Kalman filter design with the help of computer software. (Discrete case).
18. Explain the separation theorem and its application for synthesis of optimal linear continuous control systems with stochastic disturbances.
19. Explain the separation theorem and its application for synthesis of optimal linear discrete control systems with stochastic disturbances.
20. Describe the procedure of optimal stochastic control synthesis on the basis of separation theorem with the help of computer software.

21. Explain the conception of robust control systems. Describe the relationship between robustness and performance of control. Explain the conceptions of sensitivity and complementary sensitivity.

22. Explain the conceptions of H ∞- and H2-norms. Describe their application in the robust control theory.

23. Explain the conception of robust stability. Explain the Kharitonov algebraic criterion of robust stability.

24. Explain the conception of random processes in automatic control systems. Describe the conception of correlation and cross-correlation functions of ergodic random processes and their properties.

25. Explain the physical sense of power spectral densities and cross spectral densities of the random processes. Describe the relation between correlation time and noise bandwidth.

26. Describe the application of Wiener-Khinchine theorem for SISO and MIMO continuous and discrete systems.

27. Explain the conceptions of white noise and forming filter. Describe the conception and application of Wiener factorization for power spectral density.

28. Describe the response of SISO continuous and discrete dynamic systems on random disturbances.

29. Describe the response of MIMO continuous and discrete dynamic systems on random disturbances.

30. Explain the conception of frequency responses of digital systems and write down their properties. Describe the conception of stroboscopic effect and application of Kotelnikov-Shannon (sampling) theorem.

Recommended literature

1. Burns R.S. Advanced Control Engineering. – 2001. – 449 p.

2. Shinners S.M. Control System Design. – John Wiley & Sons, Inc., 1964. – 523 p.

3. Казак В.Н., Туник А.А., Салимон В.И.. Основы автоматизированого управления летательными апаратами.– К.: 2000, – 242с.

4. Квакернаак Х., Сиван Р. Линейные оптимальные системы управления.– М.: Мир, 1977. – 650с.

5. Тунік А.А., Абрамович О.О. Основи сучасної теорії управління. – К.: НАУ-друк, 2010. – 260с.

List of questions on the discipline “Information and Measuring Elements of Airborne Control Systems”

1. Give definitions and examples of information and measuring elements of the parametric and generator type.
2. Give classification of information and measuring elements by different possible signs.
3. Characterize factors, which influence on accuracy and reliability of information and measuring elements of airborne and control systems.
4. Describe methods, which may be used for physical parameters measurements.
5. List basic phases of aviation information and measuring elements design.
6. List criteria that may be used for comparison of the sensitive element of aviation information and measuring devices.
7. Represent an order of calculation of static characteristics of aviation information and measuring elements.
8. List phases of analysis of dynamic characteristics of aviation information and measuring elements.
9. List typical influences, which may be used for aviation information and measuring elements dynamic models testing.

10. Give definition of sensitivity of information and measuring elements of airborne and control systems.

11. List typical errors of information and measuring elements of airborne and control systems.

12. Give definition of reliability of information and measuring elements of airborne and control systems.

13. Give definition of accuracy of information and measuring elements of airborne and control systems.

14. List basic information and measuring elements of airborne and control systems.

15. Give examples of basic information and measuring elements of airborne and control systems.

Recommended literature

1. АВИАЦИОННЫЕ приборы и измерительные системы./Под ред. В.Г.Воробьева.- М.: Транспорт, 1981. - 391 с.

2. Методы и средства измерения параметров движения самолетов: Учеб. / Брехин Н.И. – Х.: Фарт, 2004. – 343с.

3. ІВАНОВ І.О. Прилади та системи контролю роботи авіадвигунів та вимірювання висотно-швидкісних параметрів: Навч. посібник. – Київ: КМУЦА, 1998, -92 с.

4. ПІЛОТАЖНО – НАВІГАЦІЙНІ комплекси повітряних суден. Під-ручник. / Рогожин В.О., Синєглазов В.М., Філяшкін М.К., - Київ, 2005.

5. ВОРОБЬЕВ В.Г., ЗЫЛЬ В.П., КУЗНЕЦОВ С.В., Комплексы цифрового пилотажно-навигационного оборудования. Часть1,2. М., МГТУ ГА, 1998.

List of questions on the discipline "Functional Construction of Aviation Systems"

1. Give definition of the flight separation.
2. Describe the flight phases.
3. Draw the take-off pattern and explain it.
4. Draw the track pattern and explain it.
5. Draw the approach landing pattern and explain it.
6. Describe the phases of the approach landing.
7. List the basic tasks of the navigation and pilotage.
8. Characterize aircraft as a plant.
9. Give comparative analysis of the aviation system functions.
10. Describe a generalized structure of the aviation system.
11. Describe and characterize sensors which measure the angle and speed parameters of the aircraft motion.
12. Give characteristic of navigation methods.
13. Describe sensors which measure aircraft location coordinates.
14. Carry out comparative analysis of navigation methods.
15. List possible ways to correct the inertial navigation system.

Recommended literature

1. АВИАЦИОННЫЕ приборы и измерительные системы./Под ред. В.Г.Воробьева.- М.: Транспорт, 1981. - 391 с.

2. Методы и средства измерения параметров движения самолетов: Учеб. / Брехин Н.И. – Х.: Фарт, 2004. – 343с.

3. ІВАНОВ І.О. Прилади та системи контролю роботи авіадвигунів та вимірювання висотно-швидкісних параметрів: Навч. посібник. – Київ: КМУЦА, 1998, -92 с.

4. ПІЛОТАЖНО – НАВІГАЦІЙНІ комплекси повітряних суден. Під-ручник. / Рогожин В.О., Синєглазов В.М., Філяшкін М.К., - Київ, 2005.

5. ВОРОБЬЕВ В.Г., ЗЫЛЬ В.П., КУЗНЕЦОВ С.В., Комплексы цифрового пилотажно-навигационного оборудования. Часть1,2. М., МГТУ ГА, 1998.

List of typical problems for the discipline "Automatic Control Theory"

Problem of type 1. Determine the transfer function $W(p)$ of the system represented in fig. 1 and plot its Bode diagram.

Problem of type 2. A system with input $\psi(t)$ and output $\varphi(t)$ is described by differential equation. Determine a state space model and transfer function for this system.

Problem of type 3. Determine steady-state position, velocity and acceleration errors (under gain of input signal $\alpha = 6$) for the system represented in fig. 1.

Problem of type 4. Determine with the help of Hurwitz criterion of stability the range of gain K under which the closed loop continuous system represented in fig. 1 will be stable.

Problem of type 5. Determine with the help of Hurwitz criterion of stability the values of gain K under which the closed loop discrete system described by characteristic equation will be stable.

Problem of type 6. Determine with the help of Jury criterion of stability the values of gain K under which the closed loop discrete system described by characteristic equation will be stable.

Problem of type 7. Determine controllability and observability of the system described in state space with the help of four matrices $\mathbf{A}, \mathbf{B}, \mathbf{C}, \mathbf{D}$.

Problem of type 8. A continuous system is described in state space with the help of four matrices $\mathbf{A}, \mathbf{B}, \mathbf{C}, \mathbf{D}$. It is necessary to determine the transfer function of this system, i.e. to make the conversion from time to frequency domain.

Recommended literature

1. Automatic Control Theory: Guide to Laboratory Practical Work / Compilers : A.A. Tunik, A.M. Klipa, O.D. Gorbatyuk. – K. : NAU, 2011. – 144 p.