FINAL EXAM TOPICS

Computer Science Engineering

Databases – Computer Networking Fundamentals

Databases verbal items

1. Basic data modeling concepts – data, information, entity, property (attribute), relationship, data models, entity-relationship model concept, notation systems, complex and multi-valued attributes, weak entities.

2. Relational data model – relation, relational schema, relational database, super key, key, primary key, foreign key, indexes.

3. Creating a relational model from an ER diagram: mapping entities and relationships, mapping multi-valued attributes and special relationships.

4. Relational database normalization – redundant relational schemas, anomalies, functional dependency, Armstrong axioms, attribute set closure, decomposition, 1NF, 2NF, 3NF.

5. Relational algebra - set operations, reduction operations.

6. Relational algebra - combination operations, aggregation.

7. The SQL language – general characteristics, syntax, special relational expressions. Data definition commands: defining, modifying, deleting relational schemas, creating, deleting indexes.

8. The SQL language – Data manipulation commands: managing records. Queries, implementing relational algebra operations, subqueries.

9. The SQL language – creating and using virtual tables, active elements: constraints, triggers. The operation, role, types of triggers.

10. Concept and benefits of stored procedures. Procedure management. Creating stored SQL procedures in a learned system.

11. Operation execution mechanism, optimization SQL command processing steps. Syntax checking. Construction and optimization of operation execution graph.

12. DBMS transaction management. Task of transaction management. Transaction characterization. ACID principles. History types and their role.

13. Types and operation of DBMS locks. Locking process. Correct locking. Distributed data management in a learned system.

Computer Networking Fundamentals

1. The concept of computer network, network classification, typical applications. Communication network concepts and types: message-passing, point-to-point and channel networks. Layers of the OSI model and the tasks of each layer. Concepts of interlayer interface, protocol, NIC.

2. The concept of data transmission speed. Physical channel cut-off frequency and bandwidth. Maximum data rate on a noise-free channel (Nyquist's theorem). Characterisation of the signal-to-noise ratio, the decibel value. Maximum data rate in a noisy channel (Shannon's theorem). Wired data transmission: twisted pair. Fiber optic data transmission. Single and multimode optical cables. Types of optical connectors. Characterisation of flicker in optical fibres. Physical structure of optical cables. SPE industrial cables.

3. Ethernet-type network standards and their main characteristics: public access protocol, data rates, cabling. Ethernet frame formats. Collision detection and maximum segment length. Ethernet segment interconnection at the physical layer (using repeaters).

4. The location and functions of the data link layer. Framing, the main parts of the frame. Physical address. Error protection in the data link layer: checksum. The point-to-point (PPP) protocol. Traffic control (problem of fast transmitters, slow receivers).

5. The location and role of the Medium Access Control (MAC) sublayer. The essence and characteristics of static and dynamic channel allocation. The concept of collision. Competitive and non-competitive channel allocation protocols. Operation of the CSMA/CD protocol. Operation of the CSMA/CA protocol.

6. Interconnecting Ethernet segments in OSI layer 2. Bridge protocols (static, dynamic). Stretched-tree, remote bridges. Switching technology, types of Ethernet switches. Manageable switches characteristics

7. Location and main tasks of the network layer. Datagram and virtual circuit based service. Basic traffic management algorithms: flooding, shortest path algorithm, distance vector based traffic management.

8. The place and functions of the IP protocol. Important header information for IPv4 and IPv6 packets. IPv4 addressing scheme, IPv4 address structure. Network address and broadcast address. Classification of IP addresses. Ipv6 address types. The role of the subnet mask: dividing the network into subnets. The default gateway. Example of an IP network with multiple subnets (and routers).

9. Connecting networks at the network layer. The role and operation of a traffic controller (router). Comparison of a router and a bridge (switch). Interconnecting different types of networks. The process of sending packets in different types of interconnected networks.

10. Autonomous networks, the concept of internal and external gateway protocol (IGP/EGP). Traffic management on IP networks: RIP, RIP 2, OSPF protocol. DHCP protocol. The ARP and RARP address resolution protocols.

11. Location and functions of the transport layer. How the TCP protocol works: the concept of a port, the TCP header, establishing and breaking a connection, transmission policy, congestion management. The UDP protocol. List some "common port numbers".

12. Wireless transmission standards. Classification of wireless networks. Standards for Wlan networks. Add-Hoc and Infrastructure networks. Privacy options for wireless networks. VPN concepts and usage. Mobile networks.

13. Description of the DNS (district name system). How domain name servers work, the relationship between domain name servers. How to determine the IP address associated with a domain name identifier. Possible cases of network protection using firewall, proxy. Security protocols - SSL/TLS, IPSec, SSH.

Computer Architectures - Operating Systems

Computer Architectures verbal items

1. Number systems, conversions (2,8,10,16; whole part and fractional part). Representation of unsigned integers (2,16). Number range of 8, 16, 32, 64 and N bits. MSB, LSB. Vector interrupt system and its operation. Maskable and non-maskable interrupt, software interrupt, interrupt related instructions. Interrupt and exception.

2. Representation of signed integers in two's complement code (2, 16). Number range of 8, 16, 32, 64 and N bits. Sign extension, determination of (-1) times the number, related instructions. Machine instruction execution process on the Neumann machine. ILP and the pipeline, hazards (WAW, WAR, RAW, RAR) and their management.

3. Floating-point number representation (IEEE-754). The normalized shape. Binary representation of the signed ("natural") exponent. Implicit and explicit bit representation. The structure of the number in 32 bits. The main parts of the Neumann machine and their functions. Program area, data area. Stack space issue. I/O treatment. Concept of self-modifying code. The Harvard machine.

4. BCD number representation (packed, unpacked, tetrad, pseudo-tetrad, half-byte carry). BCD arithmetic support at ISA level. Unconditional branching, conditional branches after a comparison instruction, conditional branches according to status bits, conditional and unconditional procedure calls and returns, the role of the stack. Static and dynamic branch prediction, implementation with a finite state machine.

5. The concept of a logical function. The number of logical functions with N variables. Functionally complete system. Boolean algebra. Algebraic simplification of logical functions. Writing and implementation of the algebraic form of a given logic function with a truth table. Logical instructions.

6. The structure of machine instructions (four-address, three-address, two-address, 1.5-address, one-address, zero-address). RISC and CISC. Four-address machine and microprogrammed controller. SRAM and DRAM organization and addressing. Main storage protected with a parity bit. Main storage protected with error correction code (SECDED ECC).

7. Memory hierarchy (capacity, access time). Principles of cache operation, calculation of average access time, cache organization methods, operation in case of writing/reading. Digital comparator schematic diagram example, application in cache. Data storage on a moving magnetic medium (writing, reading, organization, application). Increasing reliability (RAID). HDD and SSD.

8. Organization and operation of the floating-point register/stack, RPN formula. Useful floating-point constants. Possibilities and limitations of increasing computing power. MIPS and FLOPS. Possibilities and limitations of reducing electrical power consumption.

9. From a program written in a high-level language to the HW implementation of a machine instruction with examples (levels, languages, virtual machines, interpreter, compiler). Adder/subtractor with two's complement code for multi-bit operands. Carry bit, sign bit, overflow bit, zero flag, borrow bit. Fixed-point arithmetic instructions.

10. Bus design options, comparison of TP, OC, TS. Data transmission in case of synchronous and asynchronous bus, examples. Concept of bus arbitration (decentralized, centralized, priorities). The main parts of the 1-bit ALU (decoder, logic operator, adder, inputs, outputs) and its schematic diagram.

Operating Systems verbal items

11. Operating system tasks (Extended Virtual Machine, Resource Management, Responding Machine); operating system generations; operating systems groupings; kernel structures; resources types; typical problems.

12. Operating system surfaces (programmers and users towards); Kernel API; system call classes; dual meaning of the "shell" expression; command pipe, command list; channel redirecting; command substitution; environmental variables and storage, visibility, inheritance; file sample fit; character neutralization.

13. Control structures the in shell programming language; utilities and filters: test, expr, read, cut, head, tail, grep; Regular expressions: fit, protection, special characters, neutralization; The awk programming.

14. File system related expectations; the FAT file system structure, free space management, blocks header, data areas content in libraries and files case, one file to read example; the UFS file

system structure, free space management, blocks header, one file to read example; file system attachment ("mounting") Unix in system; the /etc/fstab and /etc/mtab files; the /dev library; loopback device, soft and hard links; FUSE, VFS, NFS;

15. Linux boot order; run levels; IP configuration under UNIX: IP address assignment, netmask, routing, gateway, DNA; ports and services; DHCP, CIFS/Samba, CUPS, SSH, X11, XDMCP, thin client concept.

16. Multiprogramming and possibilities, apparent parallelism, implementations; process basic concepts (Process Control Blocks, Process Image); process states (running, ready, blocked, suspended); process state transition graphs; process shifting steps; Threads and their use in POSIX system.

17. Communication between Processes (IPC); Communication basic concepts: blocking, synchronization, addressing, numerosity, symmetry, indirectness, buffer capacity; primitive mechanisms (channel, pool); examples (signals, environmental variables, communication through files, etc.); shared memory; message queue.

18. Time scheduling, scheduling strategies; CPU scheduling tools; Scheduling decision making situations; Priority influential factors; Processes life stages; Scheduling algorithms: FCFS, SJF, Policy Driven Scheduling, RR, Multilevel Feedback Queue Scheduling; aging algorithm; examples (Vax, Unix, Linux, NT).

19. Competition situations: Communication between competitor processes, competitive situation, critical section idea, the condition for successful implementation of critical section. Competitive programming basics: interruptions prohibition, lock variable, strict alternation, Peterson's method, Test and Set Lock instructions; priority inversion; producer-consumer problem; semaphores, mutexes, monitors; 5 philosopher problem, writer-reader problem, sleeping barber problem.

20. Deadlock definition; Deadlock formation conditions (Coffman); Example for deadlock formation; Deadlock unlocking strategies (ostrich policy, recognition and recovery, prevention, dynamic solution); examples; Banker algorithm; Dijkstra algorithm.