

■ Information Technology Engineers Examination

Database Specialist
Examination
(Level 4)
Syllabus

— Details of Knowledge and Skills Required for
the Information Technology Engineers Examination —

Version 3.1

IPA

INFORMATION-TECHNOLOGY PROMOTION AGENCY, JAPAN

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Major category	Minor category	Outline	Required knowledge	Required skills
1 Master Planning of Database	1-1 Planning of corporate databases	Create medium- to long-term and short-term corporate database plans, taking into account the computerization strategy of the entire organization, the progress of information technology, and the current state of information systems. In addition, concerning independently developed databases, plan global optimization and improvement of methods for operations and maintenance for users across the organization.	<ul style="list-style-type: none"> Evaluation techniques of information systems Problem analysis techniques Construction, operations, and maintenance of databases Trends of IT (including IoT, big data, AI, etc.) 	<ul style="list-style-type: none"> Evaluating the use of databases Evaluating the maintenance of databases Managing the operations of databases Developing databases Thinking of information systems and databases from a global point of view
	1-2 Standardization of data definition	In order to maintain data definition, standardize aspects such as the method for assigning codes, the method for defining data items, consistency of data, integration of master data, distribution of data between other related systems, and the method of distribution. In addition, manage these types of information using a repository.	<ul style="list-style-type: none"> Code design Domain Data name Data items Integrity (reference constraint, primary key constraint, and check constraint) Metadata Non-structured data 	<ul style="list-style-type: none"> Designing codes Designing naming conventions for data items Designing domains Designing non-structured data
2 Requirements Definition of Database	2-1 Investigation of current status and problem analysis	Based on the computerization theme for which investment is decided, investigate business processes and data, and make decisions on the requirements for applications and databases.	<ul style="list-style-type: none"> Business contents and terms used by users Information collection methods Data analysis techniques Problem analysis techniques Decision tables 	<ul style="list-style-type: none"> Determining main source of information for user needs Practicing techniques and procedures for information collection Determining the necessary amount of information to be collected Analyzing answers from individuals and groups Selecting and collecting acquired information to determine needs Compiling and summarizing requirements information Expressing business rules using the decision table

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	2-2 Determination of work scope	Clarify the purpose of database development, and determine the scope of work. Create a project plan based on it.	<ul style="list-style-type: none"> • System environment • System architecture, hardware, and software • Construction, operations, and maintenance of databases • Product market trends • Method for calculating person-hours • Technical restriction • Risk analysis techniques • External restriction 	<ul style="list-style-type: none"> • Documenting the scope of work clearly considering the user requirements • Determining the scale, scope, and complexity of the project • Defining the project attainment criteria • Calculating person-hours for each task in the project • Examining, analyzing, and comparing products in the market, and determining their applicability to the project • Creating documents describing technical and external restrictions
	2-3 Requirements definition (initial requirements) of database	Define requirements for database design (requirements for data and its integrity), basic physical requirements for the database (capacity, RDBMS, and database layout), and requirements for the operations and maintenance of the database (requirements for data access, performance, security, operations/maintenance, and measures against disaster). In addition, conduct review on requirements definition document with database users and application developers.	<ul style="list-style-type: none"> • System development environments and system operational environments • Integration of database and business operations • Functions and operations of systems • Development, operation, and maintenance of databases • Data analysis • Identification of performance requirements • Organizational information security policies • How to ensure data integrity • Data access control • Requirements for the operations and maintenance of databases • How to proceed with review • Matters and notes to be included in the database requirements definition document • Cloud computing • Measures against disaster 	<ul style="list-style-type: none"> • Translating user needs into database requirements • Recognizing conflicting needs, and presenting solutions • Analyzing the correctness and consistency of information • Applying effective technologies to fulfill requirements • Understanding the distribution of data • Evaluating performance evaluation criteria • Determining the feasibility of performance evaluation criteria • Suggesting a plan to ensure performance • Reflecting users' security needs as database security requirements • Reflecting users' needs for the operations and maintenance as requirements for the operations and maintenance of databases • Describing priority matters explicitly • Selecting communication methods appropriate for the requirements definition review • Appropriately evaluating opposing opinions • Distinguishing functional requirements from non-functional requirements • Evaluating and selecting cloud computing • Estimating the damage to database systems in the event of a disaster

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3 Analysis and Design of Database	3-1 Creation of conceptual data models	Create conceptual data models based on data requirements analysis in parallel with designing new application. In addition, complete the model by continuing to work on it and refining it.	<ul style="list-style-type: none"> Modeling techniques E-R diagrams UML Business rules Relational models, relational schema, relational algebra, and normalization Description of workflow 	<ul style="list-style-type: none"> Analyzing the information structure Translating user needs into conceptual data models Defining entities, relationships, and attributes Defining conceptual data models using UML Performing normalization Confirming the consistency between business processes and conceptual data models Correcting discrepancy between conceptual data models Recognizing conflicting needs, and solving them Documenting conceptual data models so that application developers and users can understand them
	3-2 Verification of conceptual data models	Verify the validity of conceptual data models with users.	<ul style="list-style-type: none"> Corporate business model Business process 	<ul style="list-style-type: none"> Recognizing users' key concerns Confirming the consistency between corporate business models and conceptual data models Recognizing conflicting needs, and solving them Documenting conceptual data models so that application developers and users can understand them
	3-3 Creation of logical data models	Translate conceptual data models into logical data models. In addition, design indexes and views, and consolidate the database through normalization.	<ul style="list-style-type: none"> Relational schema Table design Index design View design Normalization Integrity constraint Data operation Data warehousing ETL (Extract/Transform/Load) and data cleansing methods Data mining Non-structured data Security 	<ul style="list-style-type: none"> Translating conceptual data models into logical data models Designing tables Designing indexes Designing views Performing normalization Designing methods to implement integrity constraints Designing data operation Designing data warehouse Designing ETL (Extract/Transform/Load) and data cleansing methods Designing non-structured data Designing with security in mind

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	3-4 Verification of logical data models	Verify the validity of logical data models (verify that the result of the verification on conceptual data models holds true for logical data models).	<ul style="list-style-type: none"> Corporate business model Business processes 	<ul style="list-style-type: none"> Verifying the suitability and accuracy of logical data model for the purpose of the project Documenting logical data models so that application developers can understand them
4 Implementation and Testing of Database	4-1 Selection and installation of RDBMS	Compare RDBMS with other data management systems for investigation, clarify an application scope of RDBMS, and select and install an appropriate RDBMS. In doing so, select an RDBMS among possible products from various vendors based on the defined criteria considering budget, functional requirements, and non-functional requirements. In addition, install and check the operation of the selected RDBMS, taking into account consistency with existing information systems and the user environment.	<ul style="list-style-type: none"> Application of RDBMS and application of other data management Product information Criteria of selection Existing environment and the environment when installing Application Development, operations, and maintenance of databases Database performance Availability Methods for introducing and evaluating RDBMS 	<ul style="list-style-type: none"> Understanding, organizing, and summarizing various needs for RDBMS Understanding, organizing, and summarizing various needs for data management other than RDBMS Understanding the advantages and problems for users Defining comparison point for selection Evaluating product information Documenting requirements for vendors Evaluating conformance with the purpose of the project Selecting RDBMS, taking into account trade-offs between cost, function, performance, and usability
	4-2 Design of physical databases	Design physical databases by performing the steps below. (1) Analyze transaction characteristics, and define the details of data usage requirements. (2) Define platform's physical environment; physical requirements for database such as file volume; response time; integrity, failure recovery, security; and operations/maintenance requirements. (3) Determine the architecture, whether centralized, distributed, or coordinated linkage (or collaboration) between systems, taking into account the necessity of data deployment at each site, data access performance, and security, etc. In the case of a distributed architecture or coordinated linkage between systems, determine how the data linkage is to be handled, including distributed access, replication, etc.	<ul style="list-style-type: none"> Target environment Target RDBMS Techniques to calculate the amount of data Transaction analysis techniques Analysis techniques for critical processes Backup and recovery Development, operations, and maintenance of databases Database access performance Data operation Lifecycle of data (CRUD) Distributed system and distributed database Replication Data linkage Client/server system and Web system Advantages and disadvantages of centralized/distributed database Network architecture Storage virtualization and server virtualization Selection of data types 	<ul style="list-style-type: none"> Evaluating target environment Predicting transaction bottlenecks, and suggesting improvements Breaking down database requirements into detailed system requirements Designing backup and recovery methods Estimating database access performance Designing data operation Determining system architectures which meet non-functional requirements and documenting them Identifying technical problems, and suggesting solutions for them Designing distributed data layouts Selecting and evaluating an appropriate storage virtualization technology Designing databases appropriately in a virtualized server environment Understanding logical data models, and implementing them as physical databases Calculating required disk space

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		<p>(4) Design physical database, taking into account the functions and restrictions of the target RDBMS. In addition, calculate required disk space and configure lock control method.</p> <p>(5) Perform the following tasks, taking into account the performance and maintainability:</p> <ul style="list-style-type: none"> • Design columns • Design table partitioning • Denormalize tables, choose access path and indexes • Tune performance based on trade-offs between efficiencies of storage, access, and computation • Consider improving the availability of files using RAID if necessary • Improve application performance through compliance with application development rules, optimal design of SQL statement (DML), and the tuning of access paths • Obtain basic figures on processing performance (SQL, utilities, tools, etc.) in target RDBMS • Estimate performance (processing time, throughput, capacity, etc.) based on the basic performance figures of the target RDBMS • Adjust resources based on performance estimates <p>(6) Determine physical layout of the database, taking into account the alternative database, distribution to multiple disks, the order in which to store data, and measures against failure.</p> <p>(7) When replication is used, determine how it is to be handled.</p>	<ul style="list-style-type: none"> • Data compression • Data integrity • How to calculate the amount of data • Exclusive control • How to select access paths • How to adjust normalization • How to select indexes • Disk space assignment • Table partitioning • Availability of disks and databases • Security design • Encryption • Basic figures on processing performance (SQL, utilities, tools, etc.) in target RDBMS • Performance estimation • Replication and data linkage • OLTP (queuing theory) • CRUD 	<ul style="list-style-type: none"> • Selecting and evaluating appropriate methods for exclusive control • Designing and evaluating appropriate indexes • Improving performance by partial denormalization • Designing data layout on disks, taking availability into account • Designing data layout on disks, taking performance into account • Designing table partitioning • Fulfilling security requirements • Selecting and incorporating encryption features • Obtaining basic figures on processing performance (SQL, utilities, tools, etc.) in target RDBMS and evaluating appropriateness of performance • Estimating performance and assessing whether performance requirements are met • Designing replication

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	4-3 Implementation	<p>Implement the database on RDBMS by performing the steps below.</p> <ol style="list-style-type: none"> (1) Define actual database in the following order: define database → define tables → define indexes → define views → define access rights. (2) Load the test data onto defined tables. (3) Simulate the response. (4) Simulate the recovery procedure to be taken when failure occurs. (5) Educate and guide application developers. 	<ul style="list-style-type: none"> • Database definition using SQL • Implementation of integrity constraints • RDBMS utilities • Implementation of security 	<ul style="list-style-type: none"> • Defining database on target RDBMS, and taking the leadership of the definition • Implementing integrity constraints • Operating RDBMS utilities • Implementing security requirements
	4-4 Testing and migration	<p>Test the database by performing the steps below.</p> <ol style="list-style-type: none"> (1) Evaluate the performance, security, integrity, and backup/recovery by performing a database access test, and check conformance to user requirements. (2) Create, distribute, and store a database operations and management manual. (3) Conduct operation training based on the database operations and management manual. <p>Migrate data by performing the steps below.</p> <ol style="list-style-type: none"> (1) Determine tables to be migrated. (2) Determine how to convert data items based on correspondence between old and new tables. (3) Evaluate data quality and determine appropriate data cleansing method. (4) Determine data migration processing method based on the migration period and environmental conditions such as table space and communication line capacity. (5) Confirm that the data migration processing method works, obtain basic performance figures, and estimate migration time. (6) Perform the data migration. 	<ul style="list-style-type: none"> • Test techniques for database • How to use test tools • Procedures when abnormalities are found • Benchmark testing • How to use migration tools • Performance measurement (in the target environment) • Masking data for security enhancement during testing • Data migration processing methods • Data quality evaluation • Data cleansing methods 	<ul style="list-style-type: none"> • Creating the test data • Pointing out problems in the database, and evaluating the impact on users • Creating correct and understandable manuals • Designing and conducting data migration • Creating measurement scenarios to properly evaluate performance • Measuring performance and assessing whether it meets performance requirements • Designing and implementing data masking • Designing and leading data migration • Evaluating data quality • Designing data cleansing methods

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		<p>Upgrade the version of the RDBMS product by performing the steps below.</p> <ol style="list-style-type: none"> (1) Investigate whether there are any non-compatible functions, and determine the scope of their impact on existing business operations. If there is an impact, take measures against it. (2) Investigate whether any access paths have changed, and if so, take measures against them. 	<ul style="list-style-type: none"> • RDBMS product versions 	<ul style="list-style-type: none"> • Determining the impact of the upgrade and taking measures against it
5 Operations and Management of Database System	5-1 Planning of the operations and maintenance of database systems	<p>Create a plan concerning the operations and maintenance of database systems focusing on the items below.</p> <ol style="list-style-type: none"> (1) Framework and method to operate the database under normal and abnormal conditions (2) Target and method to monitor the database (3) Performance, failure/recovery, and security management of the database (4) Database maintenance- and preservation of data integrity 	<ul style="list-style-type: none"> • Monitoring methods • Monitoring tools • Hardware maintenance • Add-on hardware • Software maintenance • Backup and recovery • System monitoring • Performance management • Data integrity • Data security • Methods to create operational plans 	<ul style="list-style-type: none"> • Planning operations and maintenance of databases, taking budget into account • Planning capacity • Creating operational procedures based on operations and maintenance plans • Creating monitoring procedures based on operations and maintenance plans
	5-2 Operations and maintenance of database systems	<p>Operate and maintain the database system by performing the tasks below.</p> <ol style="list-style-type: none"> (1) Collect and analyze monitoring data in an effort to detect problems. Provide solutions for each detected problem without affecting the business. In addition, continuously monitor the database to ensure performance, swift response to failures, and information security. (2) Reconfigure the database appropriately in accordance with the change in RDBMS and application in the target environment in line with the operations and maintenance plan. (3) Maintain a database operations and management manual. 	<ul style="list-style-type: none"> • Methods to collect monitoring data • How to use monitoring tools • Techniques to analyze monitoring data • Information concerning version-upgrade of OS and middleware and their effect • Utilities for operations and maintenance 	<ul style="list-style-type: none"> • Analyzing the monitoring data • Determining appropriate timing for updating OS and middleware • Updating OS and middleware • Taking advantage of operations and maintenance utilities

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		<p>(4) When a problem (incident) occurs, determine the problem and identify the cause.</p> <p>(5) Based on the identified cause, request fixes and improvements to the relevant person in charge.</p>	<ul style="list-style-type: none"> • Problem determination 	<ul style="list-style-type: none"> • Identifying causes
	5-3 Management of database systems	<p>Manage the database system by performing the tasks below in order to maintain data integrity, to ensure availability and performance desired by users, and to plan appropriate capacity planning.</p> <p>(1) According to the operations and maintenance plan, periodically check that data integrity is preserved.</p> <p>(2) Maintain the physical structure of the database so that database access is provided without delay.</p> <p>(3) Monitor the execution status of backup, and manage the implementation of the operations and maintenance plan.</p> <p>(4) Monitor the effect of database security measures, and provide users with advice, education, and training concerning information security.</p> <p>(5) Create audit documents based on the database audit procedure, and provide accurate explanations when auditing.</p> <p>(6) Have a dry run of measures against disaster.</p>	<ul style="list-style-type: none"> • Integrity • Backup and recovery • Reorganization of database • Capacity management • Data resource management • Techniques to measure resource usage • Database security • System audit • Database audit procedure • Measures against disaster 	<ul style="list-style-type: none"> • Verifying that the integrity is preserved • Maintaining the physical structure of the database so that database access is ensured • Measuring resource usage, and estimating increase in resource usage • Determining the need for increasing resource • Identifying the abnormal usage of resources • Understanding system audit standards, and implementing measures conforming to them • Designing, implementing, and evaluating measures to protect the database from disaster • Recovering and repairing damaged database systems, and formulating action plans required for continuity of operations
	5-4 Performance tuning	<p>(1) Monitor hardware performance and the status of access paths, detect bottlenecks, and manage/improve performance so that database access requests are serviced without delay.</p> <p>(2) Monitor the resource usage arising from applications, and manage capacity in order to ensure optimal resource usage.</p>	<ul style="list-style-type: none"> • Performance design • Performance estimation • SQL • Transaction management • Exclusive control • Table design • Index design • Physical layout • Disk access • Performance improvement techniques 	<ul style="list-style-type: none"> • Estimating performance • Identifying bottlenecks • Creating performance tuning measures • Verifying the effect of tuning • Determining the need for increasing resource

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	5-5 User support	<p>Facilitate the following with the aim of effectively using the database and improving the system.</p> <ol style="list-style-type: none"> (1) Provide an application development environment, and support application developers. (2) Provide a database service which ensures accessibility required by users. (3) Collect and analyze new requests from users, and suggest improvements. In addition, evaluate the structure of the database, and suggest improvements to the system so that it is well adapted to the new business environment. 	<ul style="list-style-type: none"> • System environment • Application • Development, operations, and maintenance of databases 	<ul style="list-style-type: none"> • Building a development environment, taking into account the convenience of application developers • Maintaining the physical structure of the database so that database access is ensured • Translating new user needs into database requirements • Analyzing the impact of new user needs on the existing database • Confirming the consistency between new business processes and databases

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2016-09