

# The Most Used Spring Annotations

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## Component Annotations

Used to define Spring-managed beans in your application.

- **@Component** – General-purpose stereotype annotation. Spring detects it during component scanning and manages its lifecycle as a bean.
- **@Service** – Specialization of **@Component**, intended for service-layer classes containing business logic.
- **@Repository** – Indicates a data access object (DAO). Also enables exception translation, converting DB-specific exceptions into Spring's **DataAccessException**.
- **@Controller** – Marks a class as a web controller in Spring MVC. It handles HTTP requests and returns views.
- **@RestController** – Combines **@Controller** and **@ResponseBody**, meaning every method returns data (like JSON/XML) instead of a view.

## Configuration Annotations

Define beans, control scanning, and manage environment setup.

- **@Configuration** – Marks a class that contains **@Bean** definitions. Spring uses it to generate bean definitions and service requests.
- **@Bean** – Declares a bean to be managed by Spring. Used in methods inside a **@Configuration** class.
- **@ComponentScan** – Tells Spring where to scan for components (classes annotated with **@Component**, **@Service**, etc.).
- **@PropertySource** – Loads properties from a **.properties** file into Spring's Environment.
- **@Value** – Injects values from property files or expressions into fields or methods.
- **@Import** – Allows importing additional configuration classes.
- **@Profile** – Conditionally registers a bean based on the active Spring profile (**dev**, **test**, **prod**, etc.).
- **@Conditional** – Register a bean only if a specific condition is met (e.g., presence of a class or property).
- **@Lazy** – Defers bean initialization until it's actually needed. Great for performance optimization.
- **@DependsOn** – Specifies bean initialization order by declaring dependencies.

- **@Primary** – When multiple beans of the same type exist, this one gets autowired by default.
- **@Order** – Controls the order in which components are applied or loaded (e.g., filters or interceptors).
- **@Scope** – Defines bean scope: **singleton** (default), **prototype**, **request**, **session**, etc.
- **@Qualifier** – Helps resolve conflict when multiple beans of the same type are available by specifying which one to inject.

## Dependency Injection Annotations

- **@Autowired** – Automatically injects a dependency by type. Can be applied to constructors, fields, or setters.
- **@Resource** – JSR-250 standard. Injects by name (first), then by type.
- **@Inject** – JSR-330 standard. Functions like **@Autowired**, but without Spring-specific options like **required=false**.
- **@Required** – Ensures that a property must be set in Spring config. Throws error if not initialized (now deprecated in favor of constructor injection).

## Spring Boot Annotations

- **@SpringBootApplication** – Combines **@Configuration**, **@EnableAutoConfiguration**, and **@ComponentScan** in a single annotation to bootstrap a Spring Boot app easily.
- **@EnableAutoConfiguration** – Tells Spring Boot to auto-configure your application based on the dependencies present on the classpath.
- **@ConfigurationProperties** – Binds external configuration (like from **application.properties**) to a POJO and validates them using JSR-303/JSR-380.
- **@ConditionalOnClass** – Loads a bean or configuration only if a specified class is available in the classpath.
- **@ConditionalOnMissingClass** – Opposite of **@ConditionalOnClass**; activates if the class is not present.
- **@ConditionalOnBean** – Loads configuration or beans only if a certain bean exists.
- **@ConditionalOnMissingBean** – Loads the bean only if the specified bean is *not* present in the context.
- **@ConditionalOnProperty** – Activates beans/config based on a property's presence and value.
- **@EnableConfigurationProperties** – Enables support for **@ConfigurationProperties**-annotated beans.
- **@ConstructorBinding** – Indicates that configuration properties should be bound using the constructor instead of setters.

- **@ConfigurationPropertiesScan** – Automatically scans for **@ConfigurationProperties** annotated beans.

## Spring MVC Annotations

- **@RequestMapping** – Maps HTTP requests to handler methods; can be used at class or method level.
- **@GetMapping** / **@PostMapping** / **@PutMapping** / **@DeleteMapping** / **@PatchMapping** – Shorthand for **@RequestMapping** for specific HTTP methods.
- **@PathVariable** – Binds a URI template variable (e.g., `/users/{id}`) to a method parameter.
- **@RequestParam** – Binds a request parameter (e.g., `?name=John`) to a method parameter.
- **@RequestBody** – Automatically deserializes JSON/XML request body into a Java object.
- **@ResponseBody** – Serializes the return value of a method directly into the response body (often JSON).
- **@ResponseStatus** – Specifies the HTTP status code returned from a method or exception.
- **@ExceptionHandler** – Defines a method to handle exceptions thrown by controller methods.
- **@ControllerAdvice** – Centralized error handling for all controllers in the application.
- **@RestControllerAdvice** – Combines **@ControllerAdvice** with **@ResponseBody** for REST APIs.
- **@SessionAttributes** – Declares session-scoped model attributes.
- **@ModelAttribute** – Binds a method parameter or return value to a model attribute, or initializes it before a controller method.
- **@InitBinder** – Initializes data binders for specific fields or parameter types.
- **@CookieValue** – Binds method parameters to HTTP cookie values.
- **@RequestHeader** – Binds method parameters to HTTP header values.
- **@CrossOrigin** – Enables CORS on handler methods or controller classes.

## Spring Security Annotations

- **@EnableWebSecurity** – Enables Spring Security's web security support and provides a configuration hook for customizing security behavior.
- **@Secured** – Restricts access to a method by specifying required roles (e.g., `@Secured("ROLE_ADMIN")`).
- **@PreAuthorize** – Checks authorization *before* method execution using SpEL (Spring Expression Language). Example: `@PreAuthorize("hasRole('ADMIN')")`.

- **@PostAuthorize** – Runs after method execution to perform authorization checks on the returned object.
- **@RolesAllowed** – Standard Java (JSR-250) way to define allowed roles for accessing a method.
- **@PreFilter** – Filters elements of a collection before the method is executed, based on a SpEL condition.
- **@PostFilter** – Filters the returned collection based on a SpEL expression after method execution.
- **@AuthenticationPrincipal** – Injects the current authenticated principal (user) into a controller method.
- **@CurrentSecurityContext** – Provides access to the Spring Security context within methods.
- **@EnableGlobalMethodSecurity** – Enables method-level security annotations like **@PreAuthorize**, **@Secured**, etc.
- **@EnableGlobalAuthentication** – Allows global configuration of authentication settings (used internally by Spring).

## Spring Data / JPA Annotations

- **@Entity** – Marks a class as a persistent JPA entity, mapped to a database table.
- **@Table** – Specifies the database table name and attributes for the entity.
- **@Id** – Indicates the primary key of an entity.
- **@GeneratedValue** – Specifies how the primary key is generated (auto-increment, UUID, etc.).
- **@Column** – Maps a field to a specific database column with optional constraints.
- **@Transient** – Prevents a field from being persisted in the database.
- **@Temporal** – Specifies the precision (DATE, TIME, TIMESTAMP) for date/time fields.
- **@Enumerated** – Defines how enum fields are persisted (as a string or ordinal).
- **@Lob** – Maps a field to a large object column (e.g., BLOB or CLOB).
- **@OneToOne** / **@OneToMany** / **@ManyToOne** / **@ManyToMany** – Define relationships between entities.
- **@JoinColumn** – Specifies the foreign key column in relationships.
- **@JoinTable** – Defines a join table for many-to-many associations.
- **@Query** – Writes custom JPQL/SQL queries directly in repository interfaces.
- **@NamedQuery** – Declares a named JPQL query at the entity level.
- **@Modifying** – Marks a query method that changes the database state (insert/update/delete).
- **@Transactional** – Defines transactional boundaries; can be used at method or class level.

- **@NoRepositoryBean** – Indicates that the interface is not to be instantiated as a repository bean.
- **@Param** – Names parameters used in **@Query** statements.
- **@EntityListeners** – Specifies entity lifecycle event listeners.
- **@CreatedDate** / **@LastModifiedDate** – Auto-fill fields with creation and last modification timestamps.
- **@CreatedBy** / **@LastModifiedBy** – Auto-fill fields with user info when creating or modifying an entity.

## Spring Repository Annotations

- **@Repository** – Marks a class as a Data Access Object (DAO). It is a specialization of **@Component** and is automatically detected during component scanning. Also, it enables automatic translation of persistence-related exceptions into Spring's **DataAccessException**.
- **@Query** – Used in Spring Data repositories to define custom JPQL or native SQL queries directly on repository methods.
- **@Modifying** – Applied to repository methods that perform modifying queries (such as **UPDATE** or **DELETE**). Must be used along with **@Query**.
- **@NoRepositoryBean** – Indicates that a repository interface should not be instantiated directly. Useful when defining base repository interfaces that other interfaces will extend.
- **@Param** – Used to name parameters in a custom **@Query** so they can be referred to by name in the query.
- **@EnableJpaRepositories** – Enables scanning for Spring Data JPA repositories and configures them.

## Spring Transaction Annotations

- **@Transactional** – Declares that a method or class should be executed within a transaction. If an exception is thrown, the transaction can be rolled back automatically. You can apply it at the class level (applies to all methods) or method level individually.

Key attributes:

- **propagation**: Determines how transactions relate (e.g., **REQUIRED**, **REQUIRES\_NEW**).
- **isolation**: Defines the isolation level of the transaction (e.g., **READ\_COMMITTED**).
- **readOnly**: Marks the transaction as read-only.
- **rollbackFor**: Specifies which exceptions trigger a rollback.

- **@EnableTransactionManagement** – Enables Spring's annotation-driven transaction management. Required for **@Transactional** to work unless you're using Spring Boot (which auto-enables it).
- **@Rollback (test-specific)** – Used in test classes to indicate whether the transaction should roll back after the test.
- **@Commit (test-specific)** – Overrides the default rollback behavior for a test method and forces a commit instead.

## Spring Cache Annotations

- **@EnableCaching**: Enables annotation-driven cache management.
- **@Cacheable**: Caches the result of a method call based on parameters.
- **@CachePut**: Updates the cache without interfering with the method execution.
- **@CacheEvict**: Removes entries from the cache.
- **@Caching**: Groups multiple caching annotations on the same method.
- **@CacheConfig**: Provides common cache settings for all methods in a class.

## Spring Testing Annotations

- **@SpringBootTest** – Loads the full application context for integration testing.
- **@WebMvcTest** – Loads only the web layer (controllers) for focused tests.
- **@DataJpaTest** – Sets up JPA repositories for testing with in-memory DB.
- **@MockBean** – Adds a Mockito mock of a bean into the Spring application context.
- **@SpyBean** – Adds a Mockito spy of a bean into the context to verify interactions.
- **@ContextConfiguration** – Customizes the ApplicationContext for tests.
- **@ActiveProfiles** – Activates specific Spring profiles during test execution.
- **@TestPropertySource** – Adds specific property files or inlined properties for tests.
- **@DirtiesContext** – Marks the ApplicationContext as dirty, forcing it to reload for the next test.
- **@Sql** – Executes SQL scripts before or after tests to set up or tear down data.
- **@Rollback** – Indicates that a test transaction should be rolled back after the test.
- **@Commit** – Forces a test transaction to commit instead of rolling back.
- **@TestConfiguration** – Declares test-specific configuration beans (similar to **@Configuration**).

## Spring Cloud Annotations

These annotations help in building microservices using Spring Cloud components like service discovery, config server, load balancing, API gateway, etc.

- **@EnableDiscoveryClient** – Enables the service to register with a service discovery system (like Eureka, Consul, or Zookeeper). It makes the app discoverable by other services.
- **@EnableEurekaClient** – Specifically enables Eureka-based service registration. It's a more specific form of **@EnableDiscoveryClient** and ties the service to the Netflix Eureka registry.
- **@EnableCircuitBreaker** – Enables Circuit Breaker pattern support (Hystrix or Resilience4j) for fault tolerance. It automatically stops calling a failing service and provides fallback logic.
- **@EnableConfigServer** – Turns your application into a centralized configuration server, allowing other services to fetch their config properties from a central location (typically via Git).
- **@EnableFeignClients** – Enables the use of Feign clients, which are declarative REST clients. It automatically generates REST client implementations from annotated interfaces.
- **@FeignClient** – Declares an interface as a Feign client. It simplifies calling REST services using Java method invocations instead of writing boilerplate code using **RestTemplate**.
- **@HystrixCommand** – Wraps a method with circuit breaker logic. If the method fails or times out, a fallback method is triggered instead (deprecated in favor of Resilience4j).
- **@LoadBalanced** – When placed on a **RestTemplate** bean, enables client-side load balancing. It allows service-to-service communication using the service name rather than hardcoded URLs.
- **@EnableZuulProxy** – Enables Zuul as an API Gateway. It provides dynamic routing, monitoring, resiliency, and security to your microservices architecture.
- **@EnableResourceServer** – Marks a microservice as a protected resource server that requires OAuth2 access tokens for access.
- **@EnableAuthorizationServer** – Enables OAuth2 authorization server capabilities, allowing the app to issue access tokens to clients.

## AOP (Aspect-Oriented Programming) Annotations

AOP in Spring lets you separate cross-cutting concerns (like logging, security, transactions) from business logic using aspects.

- **@EnableAspectJAutoProxy** – Enables support for handling components marked with **@Aspect**. It allows Spring to auto-detect and apply AOP proxies using AspectJ-style annotations.
- **@Aspect** – Marks a class as an aspect. The class can contain advice (code to be executed) and pointcuts (where to execute that code).



- **@Pointcut** – Defines a reusable expression that matches join points (places in the code where aspects should be applied). Used to target specific methods or packages.
- **@Before** – Declares advice that runs **before** the matched method execution. Great for logging, authentication, or pre-checks.
- **@After** – Declares advice that runs **after** the matched method, regardless of its outcome (success or exception).
- **@AfterReturning** – Runs **after** a method executes **successfully**. It can also capture and manipulate the return value.
- **@AfterThrowing** – Runs **only if** the target method throws an exception. Useful for error logging or alerting.
- **@Around** – The most powerful advice type. It wraps the method execution—can execute code **before and after**, and even skip method execution or modify arguments and results.

## Asynchronous and Scheduling Annotations

These annotations help in executing tasks asynchronously or on a schedule without blocking the main thread.

- **@EnableAsync** – Enables Spring's asynchronous method execution. When used, any method annotated with **@Async** will run in a separate thread.
- **@Async** – Marks a method to be executed asynchronously. This allows long-running tasks (like sending emails or processing files) to run without blocking the caller.
- **@EnableScheduling** – Activates Spring's scheduled task execution capability. Without this, **@Scheduled** won't work.
- **@Scheduled** – Schedules a method to run at fixed intervals or cron expressions. Can be used for tasks like periodic cleanups or data syncing.  
**Example:** `@Scheduled(fixedRate = 5000)` or `@Scheduled(cron = "0 0 * * * *")`
- **@Schedules** – Allows multiple **@Scheduled** annotations on a single method, useful when the same method needs to run on different schedules.

## Messaging Annotations

Spring provides support for messaging systems like **JMS**, **RabbitMQ**, and **Kafka**, and these annotations help define listeners and message mapping logic.

### General Messaging Annotations

- **@Payload** – Binds a method parameter to the message payload (the actual data). Works in JMS, Kafka, and RabbitMQ.



- **@Header** – Binds a method parameter to a specific message header (like `messageId`, `correlationId`, etc.).
- **@Headers** – Injects all message headers into a `Map<String, Object>` parameter for inspection or logic.
- **@SendTo** – Specifies where the return value of a listener method should be sent. Used to route responses in message-driven systems.

## JMS (Java Message Service)

- **@EnableJms** – Enables JMS-related configuration and listener support in Spring applications.
- **@JmsListener** – Marks a method as a JMS message listener that gets triggered when a message arrives on a queue/topic.

## RabbitMQ

- **@EnableRabbit** – Enables RabbitMQ listener support and message-driven POJO configuration.
- **@RabbitListener** – Declares a method to listen for messages on RabbitMQ queues.

## Kafka

- **@EnableKafka** – Enables Kafka listener support in Spring applications.
- **@KafkaListener** – Marks a method as a Kafka message listener for a topic or set of topics.