Software Engineering

Laboratory Projects

Banking System

The Banking System, BS, is intended to computerize the basic operations of a general bank.

Individuals and services will require specialized user interfaces to handle the information and processing that is required. The interfaces can be partitioned into two categories:

1. Foreground Services, include:

- **Counter's Interface:** Allows a bank teller to open a personal savings account with bankbook or cards and to process basic banking operations, including deposit, withdrawal, transfer, loss report, reissue, freeze, and unfreeze. The minimum deposit services must cover transactions related to current deposit and all kinds of time deposit, cumulative deposit, interest withdrawal, and auto-renew of a fixed account.
- **Internet Personal Banking Interface:** Allows a customer to check information of his or her accounts, including balance and transaction history records, through internet. Operations such as account transfer and loss report must be implemented as well. An account may be a passbook account or a credit card account. A customer shall also be able to access loan and foreign exchange operations through this interface, and therefore entrances to these two function modules must be provided.
- **Loan's Interface:** Computerize the services related to loans. For the sake of simplicity, only the following six functions are considered: 1. accepting submissions of loan applications by customers; 2. computing the credit limit of a customer according to some given methods; 3. providing interface for the inspectors to examine and approve the applications; 4. executing the hierarchical examination rules for small or large amount of loans within or without the credit limit; 5. granting the loan by bank authorities; and 6. reminding the customer and the authority when the loan is reaching or has exceeded its maturity date.
- **Foreign Exchange Interface:** Allows foreign exchange business to be accessed through internet. Allows a customer to query the current exchange rate, buy and sell foreign currencies. This subsystem must provide various of search functions and be able to display the trading history of a customer.
- **Credit Card's Interface:** Provide the services related to credit cards. An internal interface is required, for recording customer's profile, application approval, account openning, credit limit updating, changing password, loss report, and cancellation of cards. An Internet interface is required as well, for the customers to check their monthly bills.

2. Background Services, include:

- **System Administration Interface:** Allows the system administrator to create, modify, and delete a single user or a group of users, and to define limits of authorities for the users. You will have to make an agreement with the rest of the interface groups on the data structures of users and user groups. Please notice that "*user*" here is not referring to a customer of the bank, but a bank clerk who will use this system.

  There are 8 roles of users: President, cashier, loan examiners, loan staff, credit card examiners, credit card customer service staff, data manipulation staff, and system administrator. Each user may take more than one role, but there is only one President.

  When data (such as interest rates, exchange rates, or fees) have to be manipulated, a manipulating script is to be inputted by a staff first. The script will not be excecuted until the President assigns an approval. That is, the script must not include any command that makes immediate manipulations. In other words, each command in the script must have an exact excecution time, accurate to second.

股票交易系统

一个完整的股票交易系统包括以下组成部分：

- 证券账户业务
  实现证券账户业务相关业务逻辑。开发工作人员管理界面，用于证券账户的开户、挂失与重新开户、销户。
- 资金账户业务
  实现资金账户相关业务逻辑。开发工作人员界面，用于录入用户信息，审批，开户，修改、密码，存款，取款，挂失，销户，资金信息查询。并实现资金账户和账户的关联。
- 交易客户端
  实现股票交易客户端的相关业务逻辑。开发用户界面，包括用户客户端申请，首次登陆，登陆，查看股票价格，查询资金账户里面的现金，查询证券账户里面的股票情况，发出购买和出售股票信息，显示交易结果。
- 股票中央交易系统
  实现股票场内交易相关业务逻辑。开发一个股票的中央交易系统，对用户发出的购买和出售股票的指令首先保存。然后匹配同一个股票的相关指令，将价格合适的两个指令进行撮合，并将交易结果放入不同的证券账户进行保存，然后修改已经匹配指令的信息。
- 网上信息发布
  实现交易信息的实时发布逻辑。对每一个股票最新的交易结果，以及近期的交易结果进行统计，并且在网站上面发布，以供用户查询。用户可以输入股票名字或代码来对股票的相关信息进行查询。
- 交易系统管理
  实现交易系统管理员对交易系统监控管理的功能。开发一个工作人员管理界面，通过识别不同用户的授权，可以查看不同股票的所有指令的数量，价格以及买卖数量的全部信息。

说明：系统安全性暂时不考虑，但是需要实现必要的登陆信息确认，同时还要保证第一次登陆时的安全证书的认证。

证券帐户业务

1. 开设证券帐户

办理证券帐户是走进股市的第一步。证券帐户可以视为投资者进入股票交易市场的通行证，只有拥有它，才能进场买卖证券。

想要开设证券帐户，开户人必须不是国家规定禁止开户的四类人员，其他人员均可以凭相关证件到交易所申请开设证券帐户：

- 证券相关从业人员（不得开立股票帐户）；
- 未成年人未经法定监护人的代理或允许者；
- 未经授权代理法人开户者；
- 因违反证券法规，经有权机关认定为市场禁入者且期限未满者；

证券帐户分为两种，分别时自然人开设的个人帐户，以及法人帐户。每个投资者，都只能开立一个证券帐户，并仅限于本人使用。

自然人开立的证券帐户为个人帐户。开立个人帐户时，投资者必须持有效的身份证件（一般为居民身份证）去证券交易所指定的证券登记机构或会员证券公司办理名册登记并开立证券帐户。个人投资者在开立证券帐户时，应载明：

- 个人股票帐户号码

- 登记日期
- 个人的姓名
- 本人性别
- 本人身份证号码
- 本人家庭地址
- 本人职业
- 本人学历
- 本人工作单位
- 本人联系电话
- 如果请人代办，代办人还须提供身份证。

法人开立股票帐户称为法人帐户，法人帐户应载明:

- 法人股票帐户号码
- 有效的法人注册登记号码
- 营业执照号码
- 法定代表人的身份证号码
- 法人姓名
- 法人联系电话
- 法人联系地址
- 法定代表人授权证券交易执行人的姓名
- 授权人有效身份证号码
- 授权人联系电话
- 授权人地址

2. 挂失，补办证券帐户

如遇投资者的证券帐户不慎丢失，为维护已办理指定交易的投资者利益，需要对证券账号实行挂失并办理重新开户手续。在具体操作中，挂失有序按照一下手续进行:

- 认真审查投资者的本人身份证或法人注册登记号。
- 证券帐户下所有的证券予以冻结;
- 按照开户的手续，重新申请证券帐户。
- 拿到证券帐户卡后，投资者就可以进入市场买卖证券了。
- 通过重新将证券帐号和资金账号关联，通过交易客户端买卖股票了。

3. 销户证券帐户

如果您因各种原因不再使用证券帐户，可凭本人身份证和证券帐户卡到指定交易的证券营业部办理（未指定的必须先办理指定交易）证券帐户销户手续。投资者在办理证券帐户销户前，必须卖出该帐户中的所有证券。

资金帐户业务

投资者委托买卖股票，须事先在证券经纪商处开立证券交易结算资金帐户，资金帐户用于投资者证券交易的资金清算，记录资金的币种，余额和变动情况。

1. 开设资金帐户

设立资金帐户时，须提交本人身份证和证券帐户卡，并将资金帐户和证券帐户相关联，投资者在资金帐户中的存款可随时提取，证券经纪商按活期存款利率定期计付利息并自动转入投资者的资金帐户。投资者委托买入时，资金帐户要有足够的余额。资金帐户需要设置交易密码，以便在交易客户端使用。另外还需要设置及取款密码，用于从资金帐户里面取出资金。帐户开设完毕，用户会得到一张类似于银行卡的资金帐户卡片。通过在证券经纪商指定的交易客户端设备上面刷卡，并输入资金帐户设置的密码登陆，便可以发出买卖股票的指令，查看资金帐户的资金情况和证券帐户内的股票信息。

活期储蓄是指无固定存期、可随时存取、存取金额不限的一种比较灵活的储蓄方式。人民币 1 元起存，外币起存金额为不低于 1 美元的等值外币。开户后发给存折，可以凭折随时存取。活期储蓄存款在办理存取业务时，应逐笔在帐页上结出利息余额。活期储蓄(存折)存款每年结息一次(每年六月三十日为结息日)。结息时把“元”以上利息并入本金，“元”以下角分部分转入下年利息余额内。活期储蓄存款在存入期间遇有利率调整，按结息日挂牌公告的活期储蓄存款利率计算利息。全部支取活期储蓄存款，按清户日挂牌公告的活期储蓄存款利率计付利息。

2. 添加和取出资金

通过资金帐户卡和密码，投资者可以从证券经纪商处追加或者取出资金帐户内的可用现金。

3. 修改资金帐户密码

资金帐户密码可以有两张方法修改。

- 投资者可以在证券经纪商处在开设资金帐户的设备上，通过输入原有密码和新密码来修改。
- 投资者还可以在证券交易客户端通过输入原有密码和新密码修改。

4. 挂失，补办资金帐户

如遇投资者的资金帐户卡不慎丢失，为维护已办理指定交易的投资者利益，需要对资金帐户卡实行挂失并办理重新开户手续。在具体操作中，挂失有序按照一下手续进行:

- 认真审查投资者的本人身份证或法人注册登记号以及证券帐户号码。
- 资金帐户卡被注销，并且帐户内所有的资金予以冻结;
- 证券帐户下所有的证券予以冻结;
- 按照开户的手续，重新办理资金帐户。
- 新资金帐户将会将复制丢失的资金帐户的全部信息，包括资金数量。此时资金和证券账号重新激活，投资者可以再次进行交易了。

5. 资金帐户销户

资金帐户是用户在某个证券经纪商处开立证券交易结算资金帐户，如果遇到某种原因，用户需要更换证券经纪商，那么就需要对资金账户进行销户。销户的手续可以分一下几个步骤:

- 投资者在销户之前，必须取出帐户内的所有现金。
- 投资者通过证券经纪商，向证券交易中心申请将资金账号和证券账号分离。证券帐户被冻结因为没有资金账号，所有投资者无法买卖股票。
- 投资者在其他证券经纪商处，开设新的资金帐户并将其和证券帐户挂钩，然后又可以进入交易所进行交易。当然，如果需要购买新的股票，需要在资金帐户种存入足够的资金。

交易客户端

投资者在开办完证券帐户并在证券经纪商处开立证券交易结算资金帐户以后，就可以通过交易客户端委托证券经纪商进行股票的买卖交易了。目前存在的委托方式有很多种，主要有以下 3 种:

- 交易设备：投资者持资金帐户卡在证券经纪商指定的刷卡设备处刷卡，并输入验证密码。然后就可以发出委托，进行交易。这是最早，也是最常见的委托方式。
- 网络：投资者通过登陆证券经纪商指定的网址，通过必要的用户和密码验证登陆。然后发出可以发出委托，进行交易。
- 电话：投资者通过申请，然后就可以致电证券经纪商指定的电话号码，通过必要的用户和密码验证，然后根据语音提示，发出委托。

这三种方法，基本流程都是一样，要实现的功能也非常相近，只是在安全验证方面略有不同。我们以第一种为例，描述客户端的主要功能，读者可以推广到网络以及电话来实现。考虑到硬件因素，我们鼓励读者实现前 2 种。

1. 登陆客户端

设立资金帐户时，投资者会得到一个资金账户卡和相关的密码。投资者可以到在证券经纪商指定的刷卡设备处（通常是在券商的营业大厅）刷卡，然后输入密码登陆到交易系统客户端。（考虑到刷卡的硬件设备问题，我们建议可以提供一个界面让用户输入卡号来代替刷卡）一旦卡号和交易密码通过认证，用户便可以进入交易页面进行以下的操作。

2. 查询证券帐户持有的股票

通过界面上的证券信息查询功能，投资者，可以查看与该资金帐户相关联的证券帐户内所有股票的信息，具体包括：

- 股票名称：投资者持有的股票名称，股票代码
- 股票总数S ：投资者持有每个股票的股数。
- 股票现在的价格：投资者持有的某个股票目前的市场价格。
- 股票持有成本：系统统计出投资者对每个股票的每股持有成本。成本计算方法是：

$\frac{\sum_{i=1}^{n} P_i * S_i}{\sum_{i=1}^{n} S_i}$ 其中P_i， S_i是第i次购买股票的价格和股数。

- 持有股票损益：系统计算出每种股票目前市场上的价格减去股票持有成本乘积持有股数，就是股票损益。

$$PS - \sum_{i=1}^{n} P_i * S_i$$

3. 查询资金帐户

通过界面上的资金信息查询功能，投资者可以查看资金帐户内资金信息

- 可用资金：投资者可以用来购买股票或者立即取出的资金数额。
- 冻结资金：投资者已经发出股票购买指令所需要的资金，虽然股票购买指令尚未执行，但是这部分资金已经冻结。当投资者发出撤销指令成功，冻结的资金又可以转化为可用资金。

4. 发出购买股票指令

通过界面上的购买股票功能可以发出购买某一股票的指令。投资需要输入以下的信息：

- 股票代码
- 购买价格（系统根据当前股票的价格给出参考价），然后用户可以接受也可以修改。
- 购买数量。购买的最大的数量，由帐户中的可用资金数量以及购买价格决定。购买股票总价不能超过资金帐户中可用资金总量。

指令的信息将会显示在投资者的界面上。

5. 发出出售股票指令

通过界面上的出售功能，可以发出出售投资者持有股票的指令。指令包括以下信息：

- 股票代码，必须是投资者持有的股票。
- 出售价格（系统根据当前股票的价格给出参考价），然后用户可以接受也可以修改。
- 出售数量。出售的最大的数量，由投资者持有的股数决定。出售股票总数不能超过投资者持有的总数。

指令的信息将会显示在投资者的界面上。对于股票买卖指令的价格，根据该股票的最大涨跌停限制（在中央交易系统部分具体说明），提示上限和下限价格的功能。因为高于上限或者低于下限的价格都不会被执行。

6. 撤销指令

通过界面上的撤销功能，可以撤销发出的指令。指令如果尚未执行，则可以撤销，如果指令已经执行拒绝投资者的请求。

7. 显示交易结果

如果指令执行成功将会更新资金帐户信息和证券帐户信息。包括以下几个方面：

- 用户指令的状态改变，从未执行变成执行成功。

- 股票帐户中股票持有数量的改变。
- 资金帐户中，可用资金数量（出售股票）和冻结资金数量（购买股票）的更新。

8. 查询股票

通过在界面的查询功能中输入股票的名字或代码，实现对股票基本信息的查询，为了简化期间，我们要求能够输出以下功能

- 股票最新成交价格
- 当前购买指令的最高价格，当前出售指令的最低价格
- 当日最高，最低成交价格
- 本周最高，最低成交价格
- 本月最高，最低成交价格
- 股票的重要公告

9. 修改密码

通过界面上的修改密码功能，投资者在正确输入原有密码以后，可以修改资金帐户投资取款密码和交易密码。

10. 高级提醒功能（选作）

高级提醒功能为了让投资者更好的掌握股票信息，执行交易。提醒功能的基本流程分为以下三步:

- 投资者设定需要提醒的股票代码，提醒的价格。
- 交易客户端实时检测该股票的价格变化。
- 当股票价格变动到投资者设定的提醒价格时，客户端发出适当提醒信息。

当然，投资者也可以随时查看或者删除设定要提醒的股票。

中央交易系统业务

中央交易系统是整个股票交易过程的核心部分。所有投资者发出的买卖股票指令都在这个自动撮合系统参加集合竞价或连续竞价，交易系统根据时间优先及价格优先的原则，对符合条件的指令予以成交，这个过程就是撮合成交。股票成交后，中央交易系统随后将成交记录反馈到相关的股票帐户和证券经纪商的资金帐户。

1. 指令撮合

当一个交易指令从客户端发出以后，会被发送到指定到中央交易系统进行撮合交易。中央交易系统是一个电子竞价系统，指令会根据股票的不同被分组。同一种股票指令，有被区分为买指令和卖指令。当买卖指令的价格相互匹配以后就形成交易。进入中央交易系统以后，指令不仅包括原有的股票信息，买卖价格信息，买卖数量信息，还增加了指令进入中央交易系统的时间信息。指令的匹配过程遵循两个原则:

- 价格优先：价格有利于交易另一方的指令优先成交。具体的说，对于一组买股票指令，价格高的优先成交；对于一组卖股票的指令，价格低的优先成交。
- 时间优先：这是在价格优先基础上来操作的。根据前面的描述，每一条进入中央交易系统的指令被加上了时间戳来标识其参与竞价的时间。那么对于，价格相同的买指令或者卖指令，进入系统早的指令（也可以理解为先发出的指令）优先执行。

说明了交易的基本原则，需要讨论一下不同买卖价格情况下交易的具体撮合情况。

- 最普通的撮合情况，即买卖价格一致。对于这种情况，系统只要进行简单的匹配，撮合形成最终交易。交易价格即使买股票指令的价格，又是卖股票的价格。
- 但是根据前面价格优先原则，我们再讨论买卖价格不同的情况。如果最低卖价仍然高于最高的买价，显然没有交易成交。但是，如果价格最低的买指令的价格仍然高于价格最高的卖指令的价格，这个时候系统需要撮合它们成交。这个时候存在着交易价格的确定算法。我们这里采用中间价格算法，也就是用买价和卖价的平均值作为最终的撮合价格。例如，有一条对 X 股票的卖指令，其价格为 12 元；另一条 X 的买指令，价格 13 元，那么根据我们的规则成交价格为（12+13）/2=12.5 元。

- 需要强调存在一种特殊情况不遵循中间价格算法，那就是价格达到涨跌幅上下限的股票，最终交易价格以规定的涨跌幅上下限价格为准。例如，如果对于上面的 X 股票，如果跌幅下限是 12.3 元，那么即使计算所的价格为 12.5 元，那么最终交易价格仍然以 12.3 元为准。
- 对于买卖价格时，有一种更加复杂的情况，那就是指令不能一次成交完成。我们采用加权价格算法。具体公式如下，P_i, S_i 分别表示某次成交的价格和股数：

$$\bar{P} = \frac{P_1 * S_1 + P_2 * S_2}{S_1 + S_2}$$

如果一条买指令需要以 13 元买入 2000 股 X 股票，但是系统中交易优先级最高的 2 条卖指令分为 12 元卖出 1500 股，12.2 元卖出 1300 股。这是时候，交易顺序应该是先买指令先与价格为 12 元的卖指令成交 1500 股，然后与 12.2 元的另一条卖指令成交 500 股。对于买指令的最终价格是比较复杂的。第一次价格是（12+13）/2=12.5 元，交易量是 1500 股；第二次价格为（12.2+13）/2=12.6 元，交易数是 500 股。那么计算结果为

$$\bar{P} = \frac{12.5 * 1500 + 12.6 * 500}{2000} = 12.525 \approx 12.53$$

2. 涨跌停限制

为了保证股票交易市场的相对稳定性，我们要求中央交易系统引入涨跌停保护机制。涨停和跌停就是涨跌达到最大限制幅度。所谓在涨跌幅限制就是规定，每天股票的最高交易价格和最低交易价格不能超出这个限制范围。

针对不同的股票，股票交易的管理机构可以设定不同的涨跌幅限制。这一设置在交易系统管理组里实现。这里我们参考上海证交所，把股票简单分为普通股和 ST 股票，它们的涨跌幅分别是 10%和 5%。并且以前一交易日股票收盘价格为基准，具体公式：

- 今日涨停价=昨日收盘价+(昨日收盘价*涨跌幅)
- 今日跌停价=昨日收盘价-(昨日收盘价*涨跌幅)

3. 结果反馈

当任何一个交易指令进入中央交易系统以后，任何关于它的交易要实时反馈到交易客户端。这种状态主要有两种：

- 指令被完全成交。当一条指令所要买卖的股票被完全成交时，需要显示完全成交。
- 指令部分成交。当指令只有一部分成交时，需要相客户端显示，指令的交易数量和交易价格

4. 指令过期

当一个交易指令发出以后，如果因为某些条件没有满足，在该交日内没有成交，那么在第二天的时候该指令已经过期了，需要从交易系统内移去。

网上信息发布系统业务

为了将交易信息能够更好地提供给各种研究机构和广大股民，需要通过建立网站实现交易信息网上发布系统。并且通过对不同用户的认证，提供不同类型的交易和统计信息。

1. 用户登陆

网页首先需要有一个最基本的用户登陆功能，当用户提供必要的登陆名和密码时，能够让用户登陆，并且赋予不同的权限。

登陆功能还要包括，用户注册和升级功能。通过必要的付费方式支持，比如输入手机号码等等，实现付费用户的注册和升级。

2. 股票价格

作为股票交易最基本的信息，股票价格的实时性非常重要。用户可以通过输入股票代码查看需要股票的信息。为了保证实时性，对股票交易的价格，要求 5 秒钟更新一次。对于股票的报价情况也要保证 5 秒钟刷新一次的频率。

3. 股票代码转换

由于股票的代码和名字比较多，需要提供股票代码和股票名字之间的转换查询功能。对于用股票名字查找股票代码的功能，需要实现一定的模糊查找。

4. 统计信息

统计信息是比较多复杂的内容，包括日 K 线，月 K 线，年 K 线。这些可以作为高级信息提供给注册用户。

K 线图又称阴阳烛，是一种表示股票价格的方法。我们以日 K 线为例，具体绘制如下：首先我们找到该日或某一周期的最高和最低价，垂直地连成一条直线；然后再找出当日或某一周期的开市和收市价，把这二个价位连接成一条狭长的长方柱体。假如当日或某一周期的收盘价较开盘价为高（即低开高收），我们便以红色来表示，或是在柱体上留白，这种柱体就称之为“阳线”。如果当日或某一周期的收盘价较开盘价为低（即高开低收），我们则以蓝色表示，又或是在柱体上涂黑色，这柱体就是“阴线”了。月 K 线和年 K 线顾名思义就是对每个月和每年进行 K 线表述。下面的图是上证 A 股的一个日 K 线图例。

5. 修改密码

通过界面上的修改密码功能，信息系统用户在正确输入原有密码以后，可以修改登陆密码。

交易系统管理业务

实现交易系统管理模块实现的是对交易系统进行监控的功能，它是一个内部管理模块，用户是股票交易所的内部人士。由于需要在适当的时候通过调整买卖双方的价格比例来促进交易，所以需要提供接口给特别的授权用户来查看不同股票的实时信息。

1. 登陆管理界面

由于不同的管理员可以看到的股票信息不一样，所以需要设置登陆界面。登陆界面包括用户名和密码当用户名和密码通过验证，显示操作界面，包括可供查看的股票列表，修改密码，股票指数等必要信息。

2. 查看股票

当用户成功登陆管理系统以后，管理客户端会根据不同的用户显示可以查看操作的股票列表。用户通过在列表里面选择股票名查看股票盘中的实时交易情况。显示的信息包括：

- 最新的成交价格
- 最新的成交数量
- 所有按价格降序排列的买指令（价格，进入系统的时间和股数）
- 所有按价格升序排练的卖指令（价格，进入系统的时间和股数）

3. 设置股票的涨跌停限制

当用户成功登陆管理系统以后，管理员通过客户端可以设置授权股票的最大涨跌幅。设置的最新限制需要在第二天生效。

4. 暂停和重启交易

当某种股票出现交易异常或者股票公司有重要信息披露的时候，需要暂停股票的交易。授权的管理员通过管理客户端将某种股票的交易暂时停止。此时，该股票的买卖指令将不能成交，同时交易客户端也不能想中央交易系统再发送该股票新的买卖指令。

当交易重新开放的条件成熟以后，管理员需要重新启动股票的撮合。交易重新启动以后，当天进入中央交易系统里面的指令马上就开始进行撮合，并且向交易客户端发送该股票交易重新启动的消息。

5. 修改密码

通过界面上的修改密码功能，管理员在正确输入原有密码以后，可以修改登陆密码。

Teaching Service System

The Teaching Service System is based on the university network to provide service for the teaching activities. The system is composed of 7 subsystems: information management, automatic course arrangement, course selection, course resource share, discussion forum, online testing, and score management.

1. Information Management Subsystem

The subsystem is responsible for user information, privilege and course information, and can provide security assurance for all system. Users of the system include students, teachers, managers and system administrators.

- User information management: managers can add, edit and delete students and teachers, can search and browse student or teacher's information, and can set the user type and rights. All users can manage personal information, fill in or modify the information, upload photos and so on.
- Course basic information management, including course name, course credits, course capacity, course assessment and other basic information of the course.
- User rights management: the user rights management is mainly reflected in other subsystems. Different types of user have different types of permissions. The system should ensure that unauthorized users can't overstep his authorities.
- System security management: responsible for the whole system's security, including the security of users' information and password, intrusion prevention management, system log records and so on.

2. Automatic Course Arrangement Subsystem

The subsystem can automatically arrange the course to reasonably utilize the schools' teaching resources according to the classroom information, course information, teacher information and other factors. The course arrangement can be adjusted by hand.

- Teaching resource management: Add or modify the basic information of every classroom, such as which campus it belongs to, classroom capacity.
- Automatically course scheduling: Based on the course information, classroom information and other comprehensive factors, the system automatically arranges the course. And the course time can't be conflicted with the classroom and teacher information. The course distribution should consistent with a uniform or with common sense.
- Manually course adjustment: According to the teacher's request or classroom resource requirements, the course arrangement can be manually adjusted without conflict.
- Schedule Inquiry: After the course arrangement is completed, teachers can query and print his class schedule. And can search every classroom's class schedule.
- Performance indicators or other constraints: The course scheduling results should consider all kinds of factors as far as possible. To fully utilize the teaching resources and facilitate students and teachers.

3. Course Selection Subsystem

The subsystem is based on certain constraints (such as course capacity, student major cultivation program) and allowed students to select the course at his own interests. The selection includes first-round selection and by-election function.

- Major cultivation program: Different students have different major cultivation programs, before course selection, every student should formulate their major cultivation program.
- Course information search and browse: students can search all kinds of course information according course name, teacher name or course id. The system will return the course details.
- Course selection: According to students' major cultivation program and the course capacity, students can select the course with his interests.
- Result view: after the course selection, students can view and print their curriculum. Teachers can get the

course selection result such as the student list, the course time.

- Course selection management: take the number of students into consideration, the system must control the number of students online, and control time about when the first-round selection starts and when the by-election starts. The administrators can manually select some course for some special students.
- Performance indicators or other constraints: the subsystem should allow at least 200 students to select course concurrently, and for the students who have login the system without any operation for a long time, the system should force them offline.

4. Course Resource Sharing Subsystem

The subsystem is mainly responsible for sharing and utilization of course resource between teachers and students and for students to upload their homework or laboratory reports.

- Resource sharing: Teachers and students can upload any resources associated with the course such courseware, exercise materials. They can also download any resource from the system.
- Homework assignment and submission: Teachers can publish the homework information and set a deadline for homework. Students should upload their homework or laboratory reports before the deadline.
- Resource management: with the growth of course resource, the administrator should manage a large amount of resource. For example, the administrator can put the resources that have been downloads by most users in a visible place.
- Resource retrieval: provide a search model for the users to retrieval resource.

5. Discussion Forum Subsystem

The course forum subsystem is to promote the communication between teachers and students, students and students.

- Forum announcement: teachers can issue a course related notification or other information.
- Post Publish: teachers and students can publish posts to discuss questions associated with the course, and the post can attach some related files.
- Post comment: User can reply any posts to give his opinion about the questions. And users can communicate with each other online.
- Forum management: The forum administrator can analyze the most viewed posts or the posts that have replied by most user in a week or a month.
- Post retrieval: provide a search model for the users to retrieval posts.

6. Online Testing Subsystem

The subsystem is mainly for teachers to generate question bank and for students to take online exam.

- Question bank management: Teachers can add, delete, modify or query the question bank which including choice question and judgment question. In the question bank, every question is composed of question and answer.
- Paper generation: Teachers can generate a paper from the question bank by hand. Test papers can also automatically generate within a limited range.
- Students online Test: After the paper is generated, students can take online testing in a limited time. The test score will come out as soon as student submits his answer.
- Score statistic analysis: Teachers can use the system's statistic analysis function to analyze the scores such as which questions are error-prone. And students can view their historical performance.
- Performance indicators or other constraints: The online testing subsystem should allow at least 100 students to take online test concurrently.

7. Score Management Subsystem

The subsystem is mainly for teachers to record student achievement and for students to query their scores, and has some statistic analysis functions about the scores.

- Score record: after the course exam, teachers can input all students' score, and before formal submission, the teacher can modify and query any scores. After submission, if the teacher wants to modify any score, he must submit an application form to explain the reason.
- Score query: if teachers have submit the course score, students can query his scores, and can get his score's statistic analysis.
- Score analysis: this function is mainly for teachers to analyze a course's score distribution, including the average score, score distribution, score ranking statistic. And the result should show in some form of chart for them to understand better. At the same time the system can show students' individual achievement in a statistical analysis form including GPA, average scores, total credits and so on.

Online Payment System

The Online Payment System is a third-party secured transactions system. Any buyer can submit payment into an account first, and then the system will notify the seller to consign the goods. Once the buyer has received and confirmed receiving their goods, the system will transfer the money to the seller's account, thus completing their web transaction.

Basic functional and non-functional requirements of the payment system are described in the rest of this document. Please make sure to read them carefully.

i. Functional Requirements

- **Module 1: Personal Account Management** Allow a basic user (i.e. buyer or seller) to register an account with his/her basic personal information such as real name, ID number and email address, and modify this information at any time. Users can be also allowed to process basic capital account operations, including setting and changing payment passwords, charging accounts, and querying account balance. Users can check their payment-records (statements) which will be organized and displayed in two forms: monthly and yearly. Users should be able to utilize all of these functions through a main interface, and links to other function modules should be available as well.

- **Module 2: Payment Transaction Processing** Allow users to check current order information, including total number of orders, list of items ordered, transaction amount, buyer and seller information, and order status. Buyers should be able to process such operations as payment and refunds, while sellers can confirm that the goods have been shipped. Trading history queries and complaint functions should be also implemented. Furthermore, the transaction flow should be recorded, as it will be used for account reconciliation and auditing. The interface of this module is needed. In the page, transaction record should be classified and displayed according to the transaction status (e.g. Processing, Non-payment, Waiting to ship, Waiting to confirm, Refunded, completed and failed) and time (e.g. Today, Last week, Last month, Last three month, Last year, one year ago). Transaction security authentication will be regarded as a plus.

- **Module 3: Online Booking** Hotel and flight online booking is a value-added service of the online payment system. Users are able to use this service to look up hotel and flight information, book rooms and tickets as needed, and use the their accounts to make payments. The basic operations include hotel and flight searches, information display, booking and payment, comment and scoring, and booking history query. The information of discount flight tickets and special offer rooms will be listed on the right side, when users make hotel and flight searches. The hotel search result can be sorted by price level, hotel star level, hot level and customer-feedback score, the flight search result can be sorted by price, flight time, none-stop and Airline Company. Note that a new role, Booking Service Administrator, should be added to the system. His job will be to manage and maintain hotel and flight information through a backstage system interface, which should be offered with the main online booking module interface.

- **Module 4: Account Reconciliation and Audit** Allow auditors to run account reconciliation and audits with the transaction flow recorded in the database when transactions are completed.

The system will generate the reconciliation data list in a proper form of last day (0:00 – 24:00) in a fixed time (e.g. 1:00am) every day. The list should include the order number, buyer and seller IDs, total amount, order status, and trade time of each transaction. In the event of an error or something to need double check, it should be logged at once, and auditors should be warned. The interface of this module should be well designed.

✧ **Module 5: System Administration** Allow administrators to maintain the system and ensure it runs smoothly. Administrators can perform the following duties through the backstage interface: add new administrators (including system and online booking), maintain administrator information, manage users (regular user, VIP user, and auditor), verify real names, and manage arbitration and blacklists. In detail, authority management should be well designed and implemented. Once someone's authority has been changed, corresponding effect should be reflected immediately. Besides, developers should build and maintain an ID database used for automating real name verification.

✧ **Other functional requirements for whole project:**

A. VIP mechanism: For users, the more using experience they have, the more growth points they will gain. The points rule should be defined rational and reasonable. Regular users will grow into VIP users once their growth points reach a pre-set value. VIP users own some particular privileges such as discount on booking deposit, higher limit on ticket or room amount etc.
B. Notification: Notification system should be designed in an overall view. No matter which page the user is on, he/she will be notified in a short time as long as following events have occurred: transaction status has changed; booking has succeeded or failed; real name verification has been approved or not; arbitration result has been declared.
C. Account charging: The form of prepaid card is recommended. The charging operation will be available in module 1, and also can be required when payment happening in module 2 and 3. The prepaid card number and password validation should be implemented in module 5.

ii. Non-functional Requirements

✧ **Security**

A. Privacy: User names and passwords for authentication purposes should prevent unauthorized users from accessing the system. Access controls should be built to prevent legitimate users from using system resources illegally. Some sensitive data, such as user name, password and capital amount, should be encrypted when they are being exchanged. The password should be encrypted before it is stored. During user login, SQL injection, password forcible cracking and forged session intrusion should all be prevented.
B. Integrality: Prevent unauthorized users from modifying and inserting data accidentally or maliciously. Data loss should be prevented.

✧ **Performance**

A. System Configuration: CPU 2.6G, Memory 2.0G, Disk 7200rpm.
B. Visit Capacity: Support 500 users concurrent access at least in the same time.
C. Capability: Support 10000 transaction records in total at least.
D. Response speed: For single user access, web response time < 1s, information search response time < 2s. For 500 users concurrent access, web response time < 2s, information search response time < 5s.

✧ **Availability**

A. Multi web browser support: The system should display and perform correctly in most of popular web browsers including Firefox and IE etc.