In [1]:
```
import pandas as pd
import seaborn as sns
import matplotlib.pyplot as plt
import numpy as np
sns.set_theme(color_codes=True)
```

In [2]:
```
df = pd.read_csv('kidney-stone-dataset.csv')
df.head()
```

Out[2]:

	Unnamed: 0	gravity	ph	osmo	cond	urea	calc	target
0	0	1.021	4.91	725	14.0	443	2.45	0
1	1	1.017	5.74	577	20.0	296	4.49	0
2	2	1.008	7.20	321	14.9	101	2.36	0
3	3	1.011	5.51	408	12.6	224	2.15	0
4	4	1.005	6.52	187	7.5	91	1.16	0

In [3]:
```
df.drop(columns='Unnamed: 0', inplace=True)
```

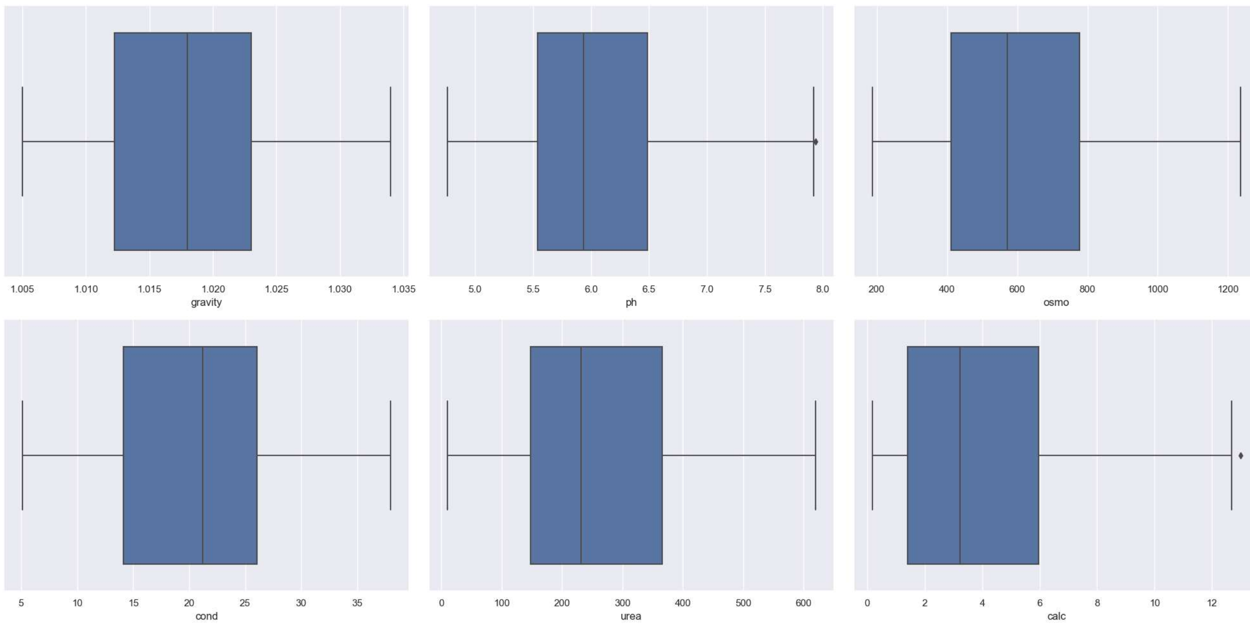
In [4]:
```
df.head()
```

Out[4]:

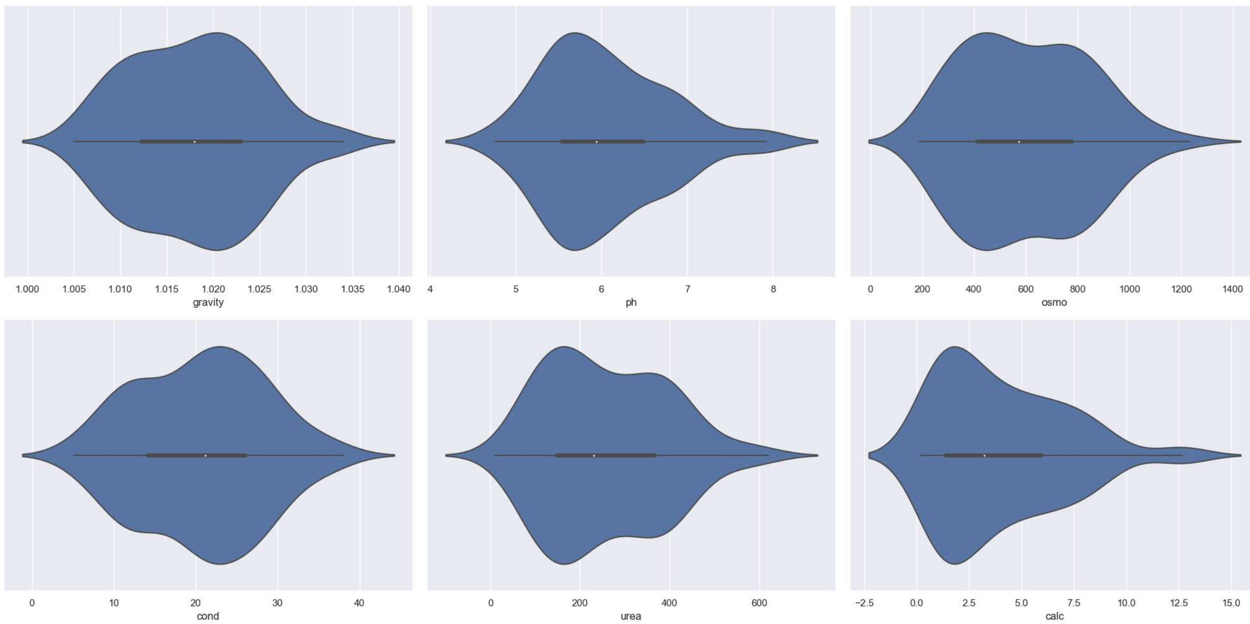
	gravity	ph	osmo	cond	urea	calc	target
0	1.021	4.91	725	14.0	443	2.45	0
1	1.017	5.74	577	20.0	296	4.49	0
2	1.008	7.20	321	14.9	101	2.36	0
3	1.011	5.51	408	12.6	224	2.15	0
4	1.005	6.52	187	7.5	91	1.16	0

Exploratory Data Analysis

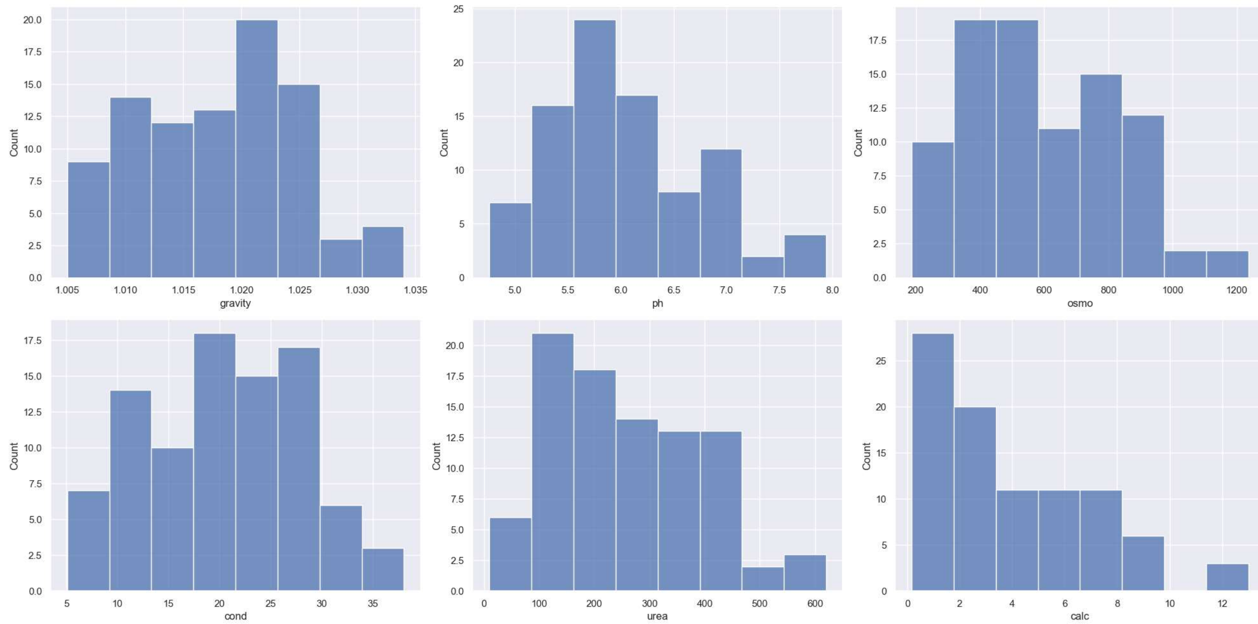
In [6]:
```
num_vars = ['gravity', 'ph', 'osmo', 'cond', 'urea', 'calc']

fig, axs = plt.subplots(nrows=2, ncols=3, figsize=(20, 10))
axs = axs.flatten()

for i, var in enumerate(num_vars):
    sns.boxplot(x=var, data=df, ax=axs[i])

fig.tight_layout()

plt.show()
```



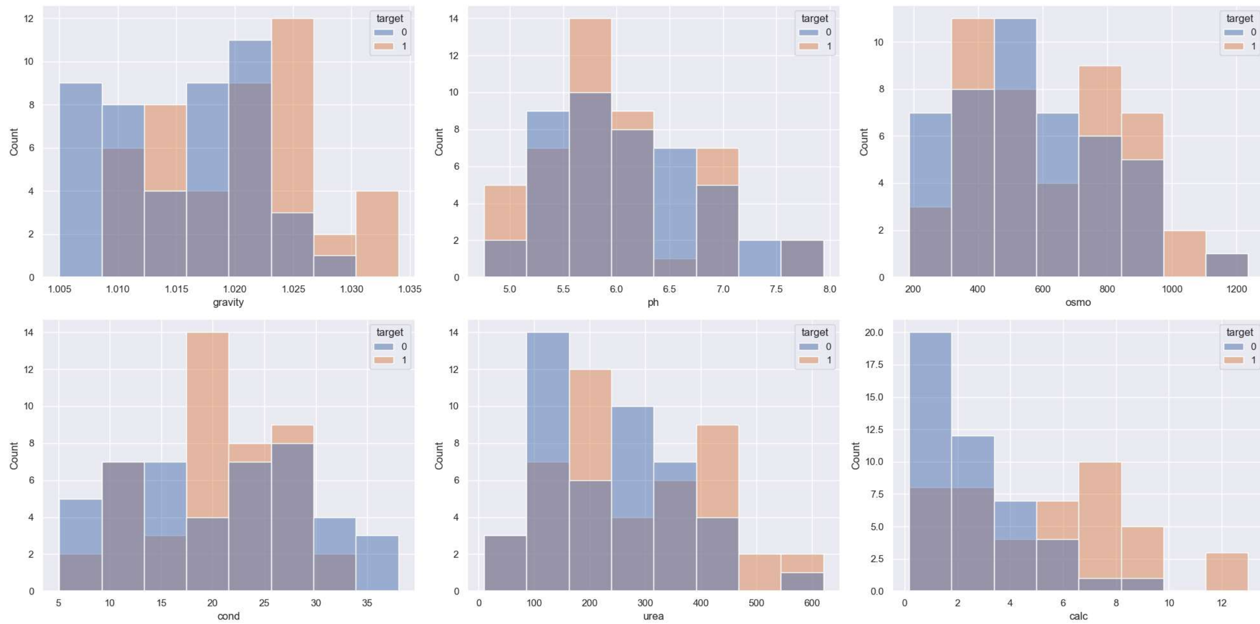
In [7]:
```
num_vars = ['gravity', 'ph', 'osmo', 'cond', 'urea', 'calc']

fig, axs = plt.subplots(nrows=2, ncols=3, figsize=(20, 10))
axs = axs.flatten()

for i, var in enumerate(num_vars):
    sns.violinplot(x=var, data=df, ax=axs[i])

fig.tight_layout()

plt.show()
```



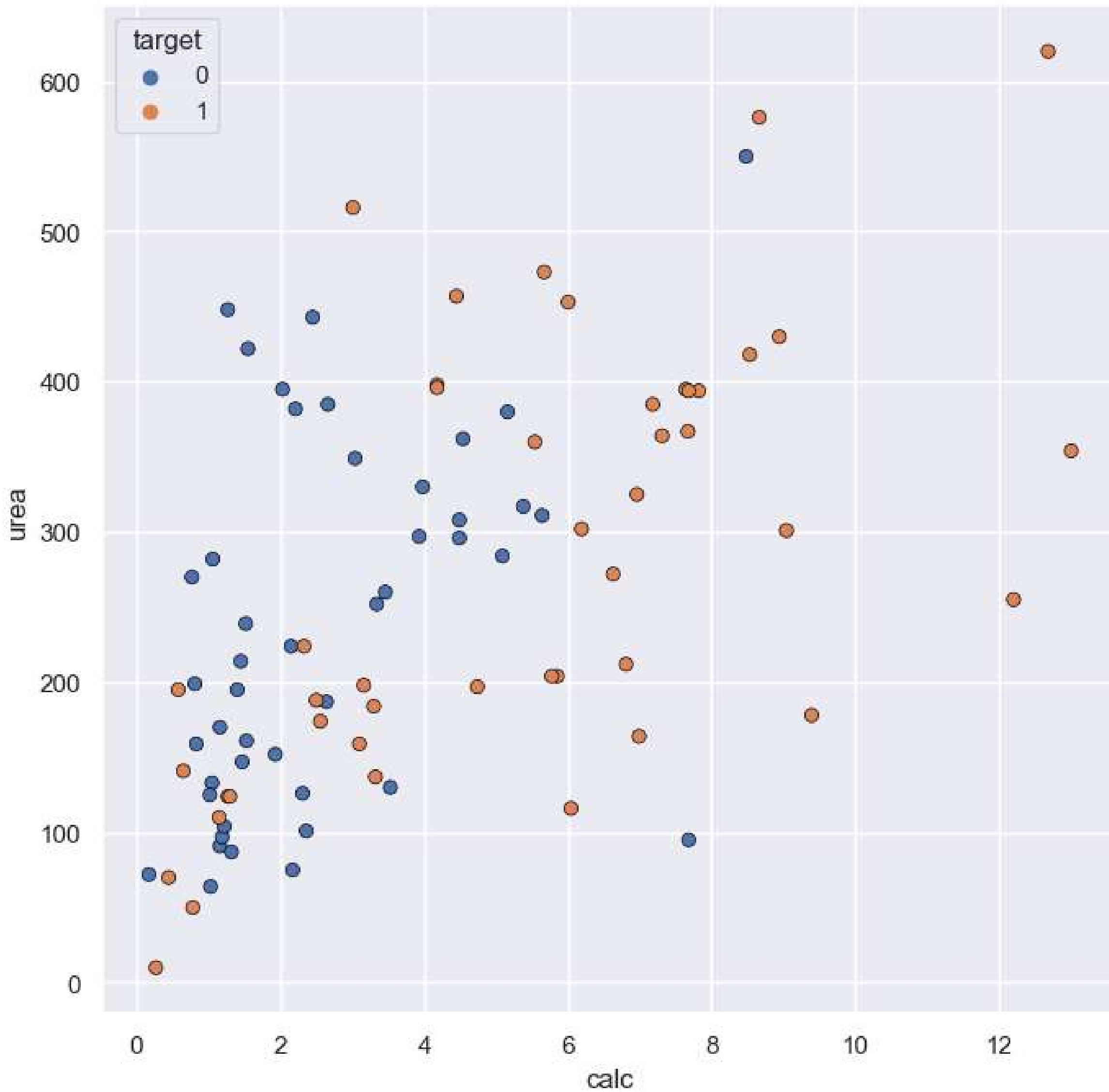
In [13]:
```
num_vars = ['gravity', 'ph', 'osmo', 'cond', 'urea', 'calc']

fig, axs = plt.subplots(nrows=2, ncols=3, figsize=(20, 10))
axs = axs.flatten()

for i, var in enumerate(num_vars):
    sns.histplot(x=var, data=df, ax=axs[i])

fig.tight_layout()

plt.show()
```



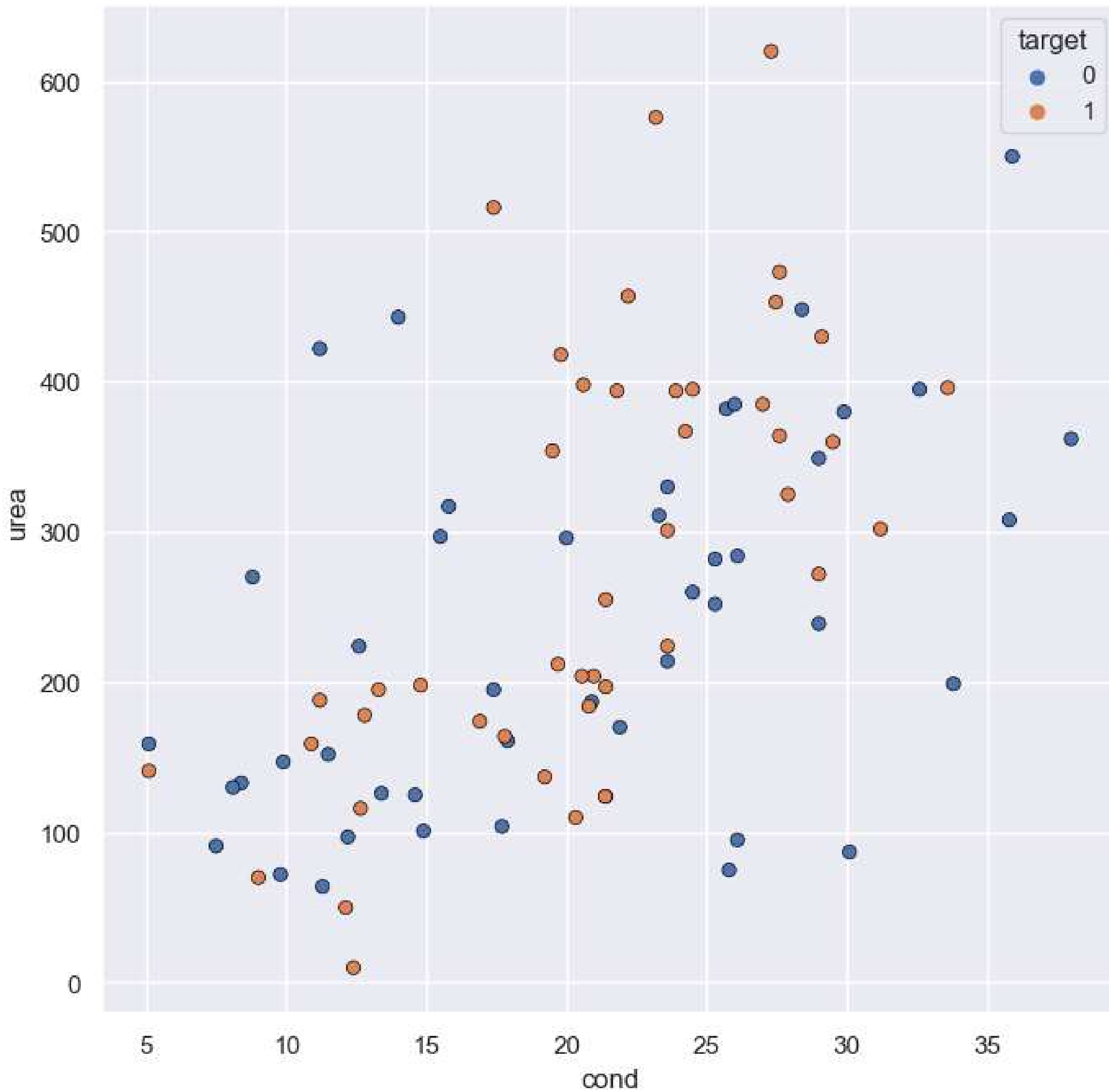
In [14]:
```
num_vars = ['gravity', 'ph', 'osmo', 'cond', 'urea', 'calc']

fig, axs = plt.subplots(nrows=2, ncols=3, figsize=(20, 10))
axs = axs.flatten()

for i, var in enumerate(num_vars):
    sns.histplot(x=var, data=df, hue='target', ax=axs[i])

fig.tight_layout()

plt.show()
```



In [16]:
```
plt.figure(figsize=(8,8),dpi=100)
sns.scatterplot(x="calc", y="urea", hue="target", data=df, edgecolor="black")
plt.show()
```



In [17]:
```
plt.figure(figsize=(8,8),dpi=100)
sns.scatterplot(x="cond", y="urea", hue="target", data=df, edgecolor="black")
plt.show()
```



Data Preproceessing

In [18]:
```
#Check missing value
check_missing = df.isnull().sum() * 100 / df.shape[0]
check_missing[check_missing > 0].sort_values(ascending=False)
```

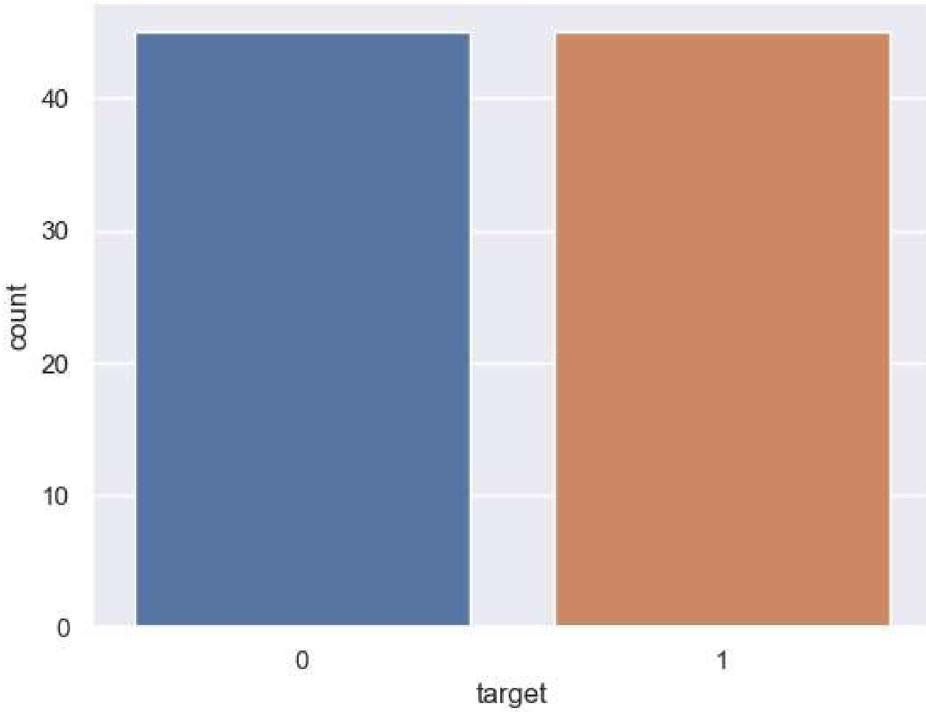
Out[18]:
```
Series([], dtype: float64)
```

Check 'Target' value is it balanced or not

In [19]:
```
sns.countplot(df['target'])
df['target'].value_counts()
```

```
D:\anaconda3\lib\site-packages\seaborn\_decorators.py:36: FutureWarning: Pass the following varia
ble as a keyword arg: x. From version 0.12, the only valid positional argument will be `data`, an
d passing other arguments without an explicit keyword will result in an error or misinterpretatio
n.
  warnings.warn(
```

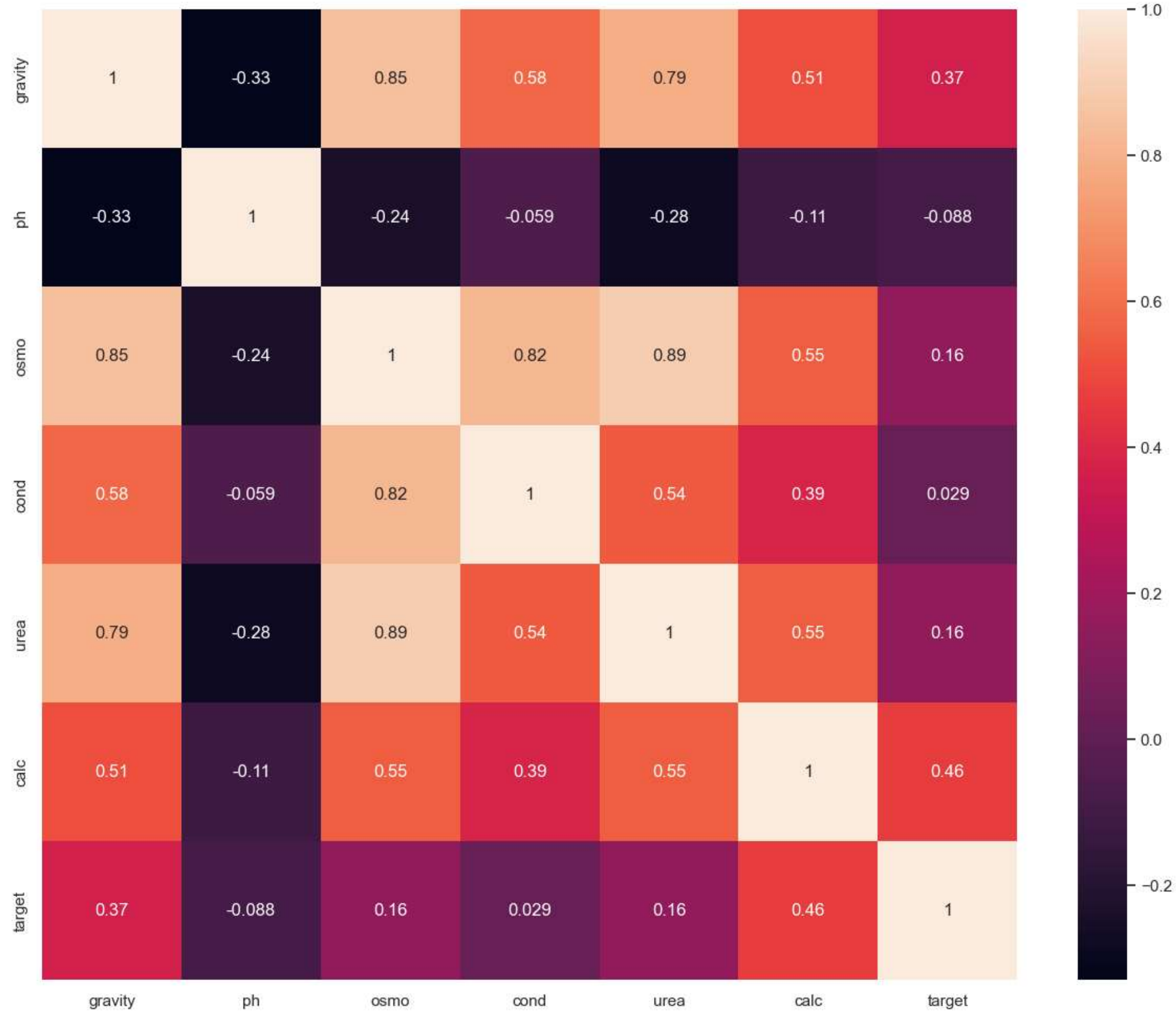
Out[19]:
```
0    45
1    45
Name: target, dtype: int64
```



There's no outlier, so we don't have to remove it

In [21]:
```
plt.figure(figsize=(15,12))
sns.heatmap(df.corr(), fmt='.2g', annot=True)
```

Out[21]: <AxesSubplot:>



Train test split

In [22]:
```
X = df.drop('target', axis=1)
y = df['target']
```

In [23]:
```
#test size 20% and train size 80%
from sklearn.model_selection import train_test_split
from sklearn.metrics import accuracy_score
X_train, X_test, y_train, y_test = train_test_split(X,y, test_size=0.2,random_state=0)
```

Machine Learrning Model Building

Decision Tree

In [24]:
```
from sklearn.tree import DecisionTreeClassifier
from sklearn.model_selection import GridSearchCV
dtree = DecisionTreeClassifier()
param_grid = {
    'max_depth': [3, 4, 5, 6, 7, 8],
    'min_samples_split': [2, 3, 4],
    'min_samples_leaf': [1, 2, 3, 4]
}

# Perform a grid search with cross-validation to find the best hyperparameters
grid_search = GridSearchCV(dtree, param_grid, cv=5)
grid_search.fit(X_train, y_train)

# Print the best hyperparameters
print(grid_search.best_params_)
```

```
{'max_depth': 7, 'min_samples_leaf': 1, 'min_samples_split': 4}
```

In [25]:
```
from sklearn.tree import DecisionTreeClassifier
dtree = DecisionTreeClassifier(random_state=0, max_depth=7, min_samples_leaf=1, min_samples_split=
dtree.fit(X_train, y_train)
```

Out[25]:
```
DecisionTreeClassifier(max_depth=7, min_samples_split=4, random_state=0)
```

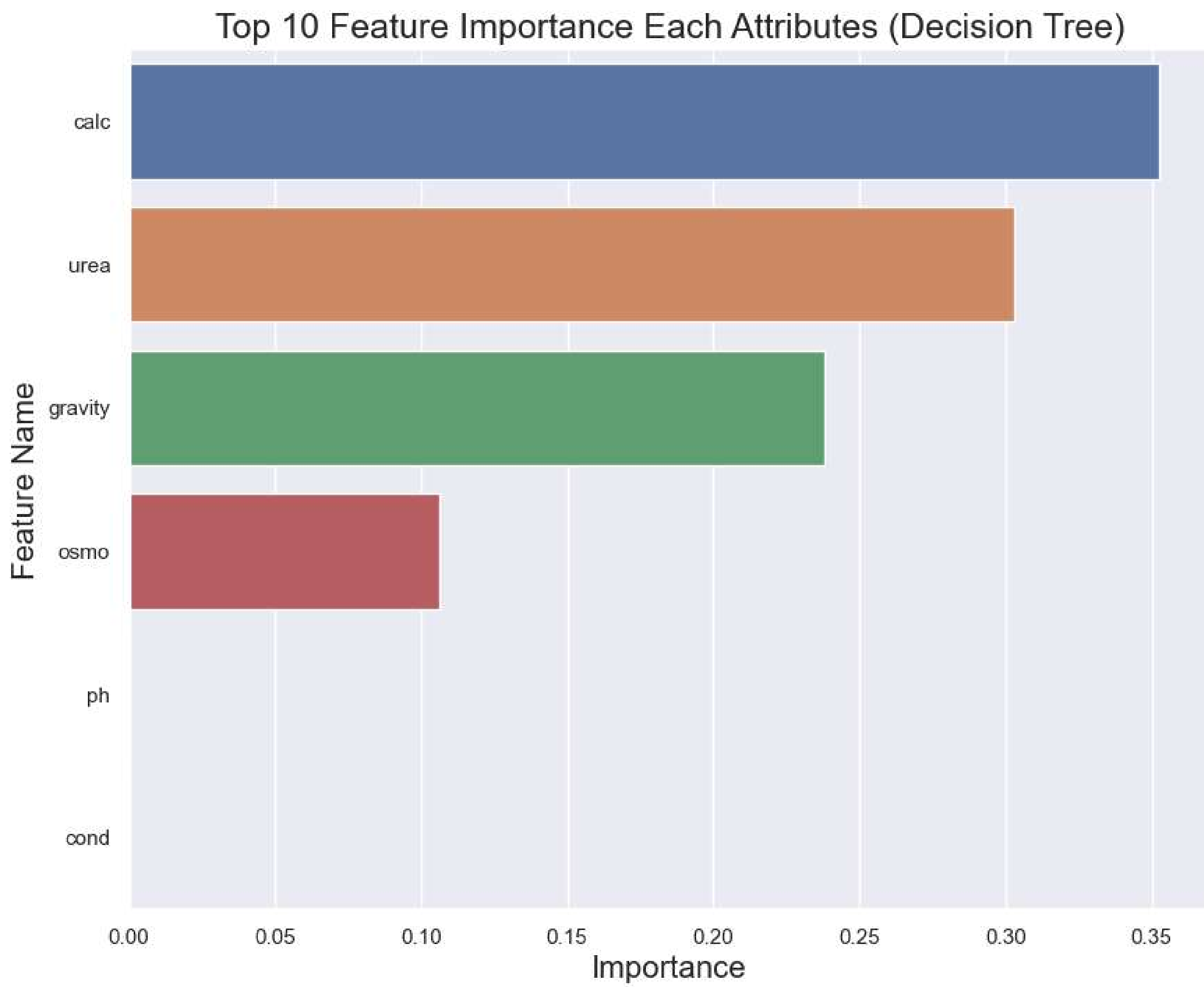
In [26]:
```
y_pred = dtree.predict(X_test)
print("Accuracy Score :", round(accuracy_score(y_test, y_pred)*100 ,2), "%")
```

```
Accuracy Score : 66.67 %
```

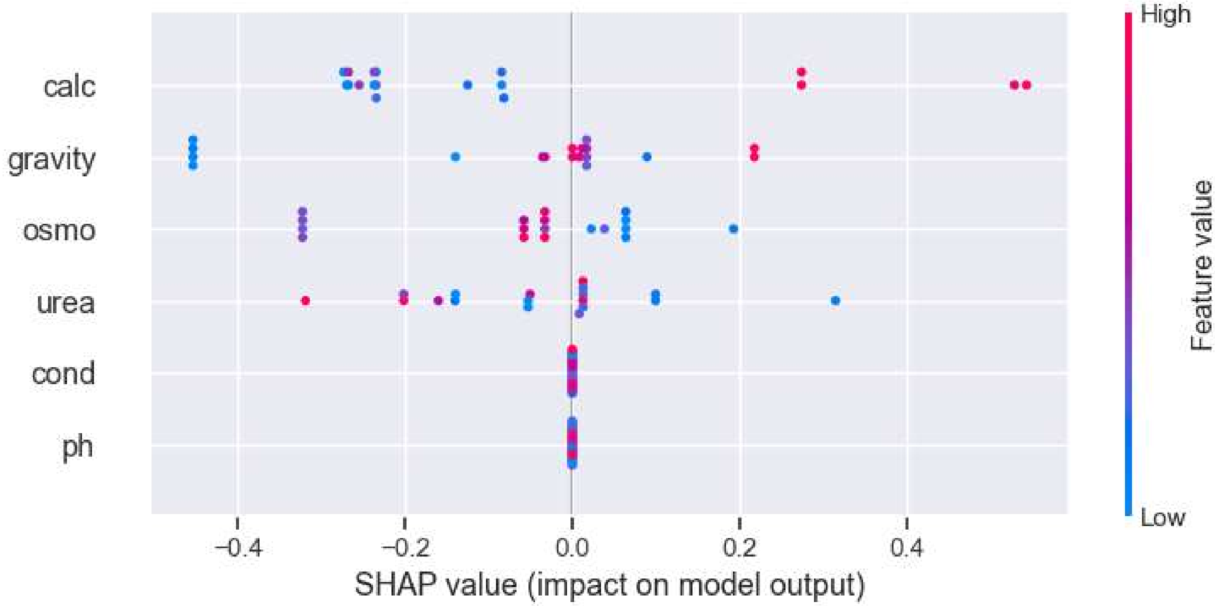
In [27]:
```
from sklearn.metrics import accuracy_score, f1_score, precision_score, recall_score, jaccard_score
print('F-1 Score : ',(f1_score(y_test, y_pred, average='micro')))
print('Precision Score : ',(precision_score(y_test, y_pred, average='micro')))
print('Recall Score : ',(recall_score(y_test, y_pred, average='micro')))
print('Jaccard Score : ',(jaccard_score(y_test, y_pred, average='micro')))
print('Log Loss : ',(log_loss(y_test, y_pred)))
```

```
F-1 Score :  0.6666666666666666
Precision Score :  0.6666666666666666
Recall Score :  0.6666666666666666
Jaccard Score :  0.5
Log Loss :  11.513014309129138
```

In [28]:
```
imp_df = pd.DataFrame({
    "Feature Name": X_train.columns,
    "Importance": dtree.feature_importances_
})
fi = imp_df.sort_values(by="Importance", ascending=False)

fi2 = fi.head(10)
plt.figure(figsize=(10,8))
sns.barplot(data=fi2, x='Importance', y='Feature Name')
plt.title('Top 10 Feature Importance Each Attributes (Decision Tree)', fontsize=18)
plt.xlabel ('Importance', fontsize=16)
plt.ylabel ('Feature Name', fontsize=16)
plt.show()
```

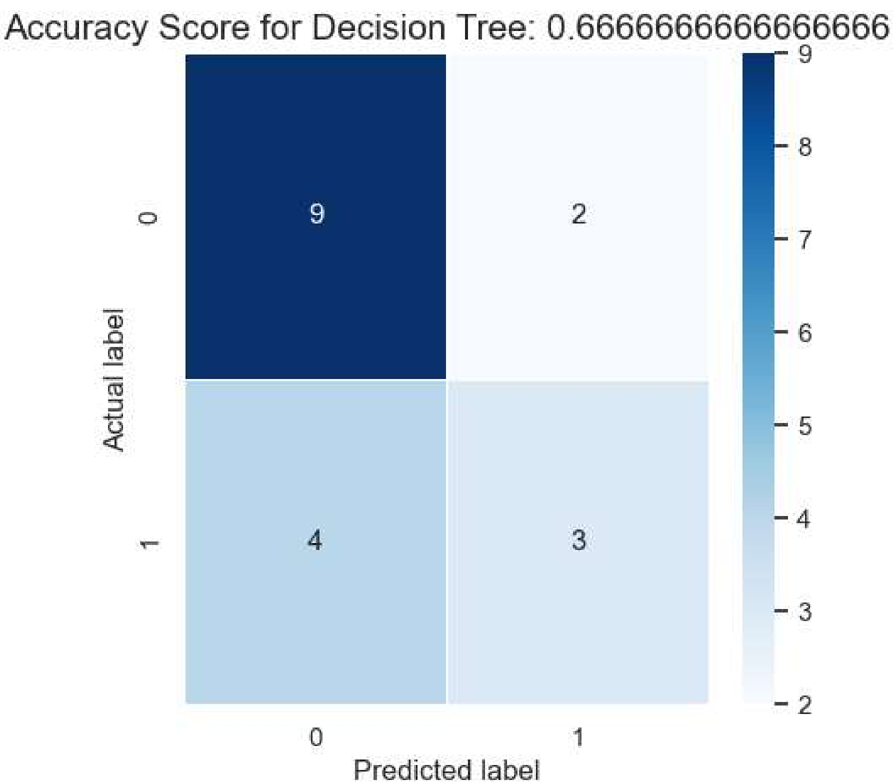


In [29]:
```
# compute SHAP values
import shap
explainer = shap.TreeExplainer(dtree)
shap_values = explainer.shap_values(X_test)
shap.summary_plot(shap_values[1], X_test.values, feature_names = X_test.columns)
```



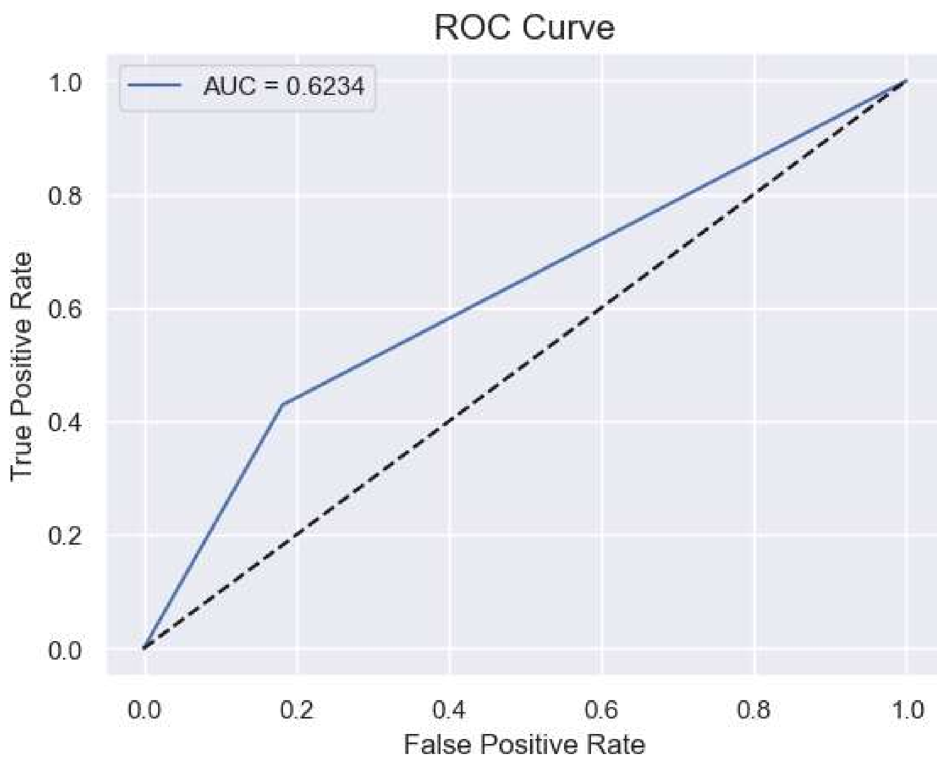
In [47]:
```
from sklearn.metrics import confusion_matrix
cm = confusion_matrix(y_test, y_pred)
plt.figure(figsize=(5,5))
sns.heatmap(data=cm,linewidths=.5, annot=True,  cmap = 'Blues')
plt.ylabel('Actual label')
plt.xlabel('Predicted label')
all_sample_title = 'Accuracy Score for Decision Tree: {0}'.format(dtree.score(X_test, y_test))
plt.title(all_sample_title, size = 15)
```

Out[47]:
```
Text(0.5, 1.0, 'Accuracy Score for Decision Tree: 0.6666666666666666')
```



In [48]:
```
from sklearn.metrics import roc_curve, roc_auc_score
y_pred_proba = dtree.predict_proba(X_test)[:][:,1]

df_actual_predicted = pd.concat([pd.DataFrame(np.array(y_test), columns=['y_actual']), pd.DataFram
df_actual_predicted.index = y_test.index

fpr, tpr, tr = roc_curve(df_actual_predicted['y_actual'], df_actual_predicted['y_pred_proba'])
auc = roc_auc_score(df_actual_predicted['y_actual'], df_actual_predicted['y_pred_proba'])

plt.plot(fpr, tpr, label='AUC = %0.4f' %auc)
plt.plot(fpr, fpr, linestyle = '--', color='k')
plt.xlabel('False Positive Rate')
plt.ylabel('True Positive Rate')
plt.title('ROC Curve', size = 15)
plt.legend()
```

Out[48]: <matplotlib.legend.Legend at 0x1aecbd067f0>



Random Forest

In [49]:
```
from sklearn.ensemble import RandomForestClassifier
from sklearn.model_selection import GridSearchCV
rfc = RandomForestClassifier()
param_grid = {
    'n_estimators': [100, 200],
    'max_depth': [None, 5, 10],
    'max_features': ['sqrt', 'log2', None]
}

# Perform a grid search with cross-validation to find the best hyperparameters
grid_search = GridSearchCV(rfc, param_grid, cv=5)
grid_search.fit(X_train, y_train)

# Print the best hyperparameters
print(grid_search.best_params_)
```

```
{'max_depth': None, 'max_features': None, 'n_estimators': 200}
```

In [51]:
```
from sklearn.ensemble import RandomForestClassifier
rfc = RandomForestClassifier(random_state=0)
rfc.fit(X_train, y_train)
```

Out[51]:
```
RandomForestClassifier(random_state=0)
```

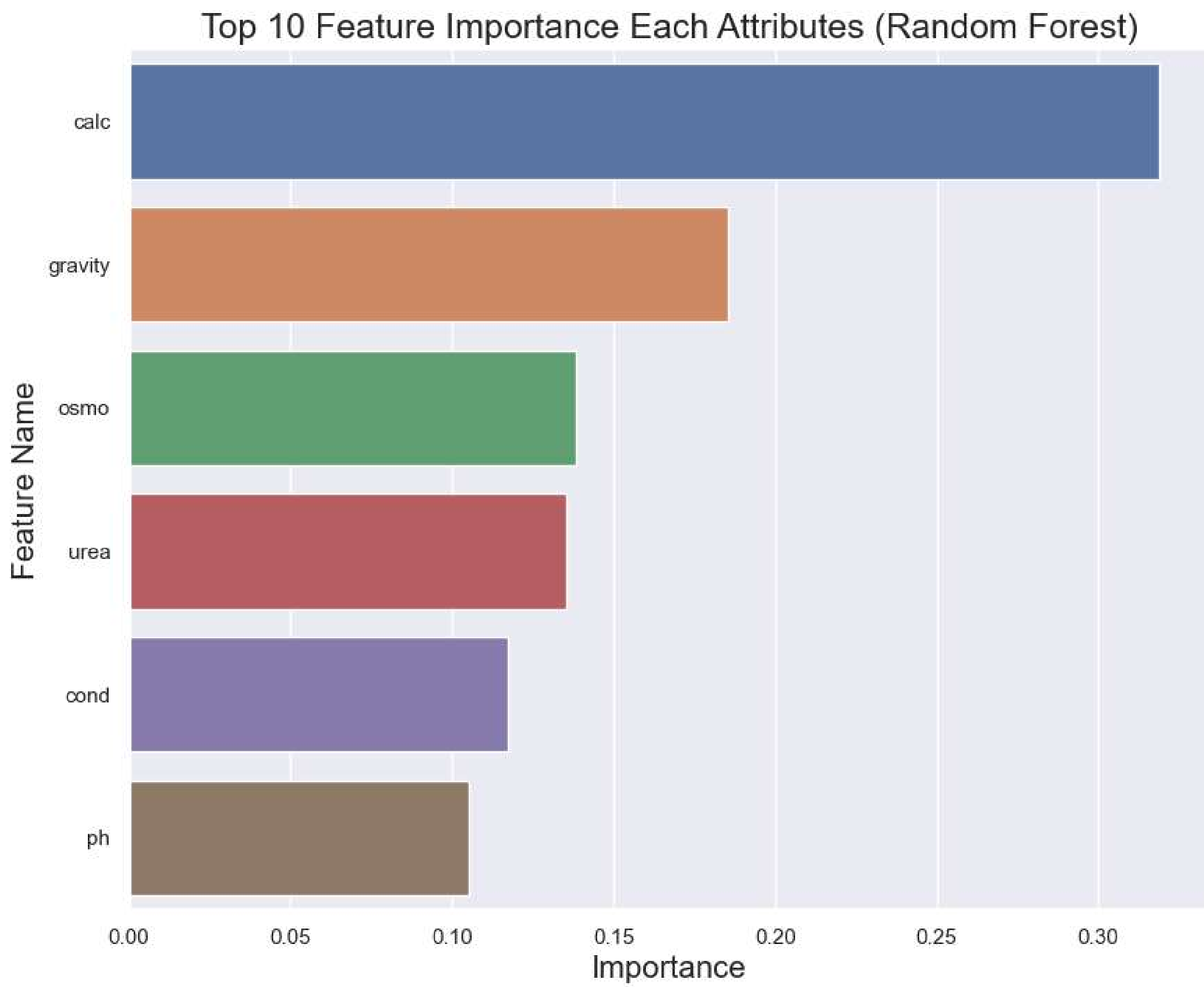
In [52]:
```
y_pred = rfc.predict(X_test)
print("Accuracy Score :", round(accuracy_score(y_test, y_pred)*100 ,2), "%")
```

```
Accuracy Score : 88.89 %
```

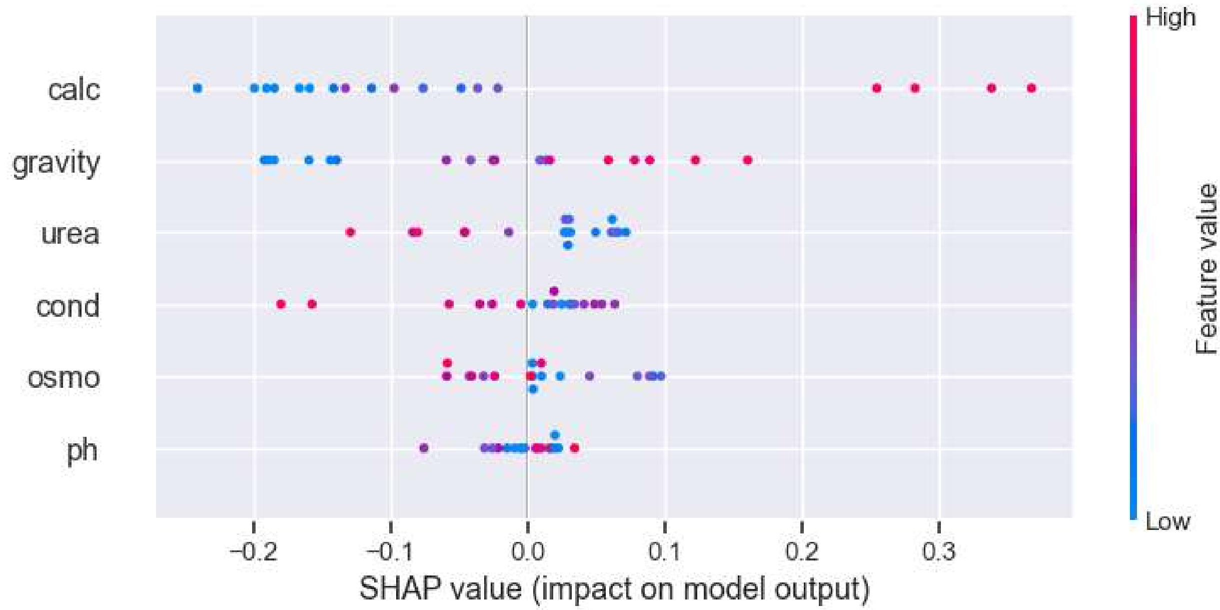
In [53]:
```
from sklearn.metrics import accuracy_score, f1_score, precision_score, recall_score, jaccard_score
print('F-1 Score : ',(f1_score(y_test, y_pred, average='micro')))
print('Precision Score : ',(precision_score(y_test, y_pred, average='micro')))
print('Recall Score : ',(recall_score(y_test, y_pred, average='micro')))
print('Jaccard Score : ',(jaccard_score(y_test, y_pred, average='micro')))
print('Log Loss : ',(log_loss(y_test, y_pred)))
```

```
F-1 Score :  0.8888888888888888
Precision Score :  0.8888888888888888
Recall Score :  0.8888888888888888
Jaccard Score :  0.8
Log Loss :  3.837686243736199
```

In [54]:
```
imp_df = pd.DataFrame({
    "Feature Name": X_train.columns,
    "Importance": rfc.feature_importances_
})
fi = imp_df.sort_values(by="Importance", ascending=False)

fi2 = fi.head(10)
plt.figure(figsize=(10,8))
sns.barplot(data=fi2, x='Importance', y='Feature Name')
plt.title('Top 10 Feature Importance Each Attributes (Random Forest)', fontsize=18)
plt.xlabel ('Importance', fontsize=16)
plt.ylabel ('Feature Name', fontsize=16)
plt.show()
```

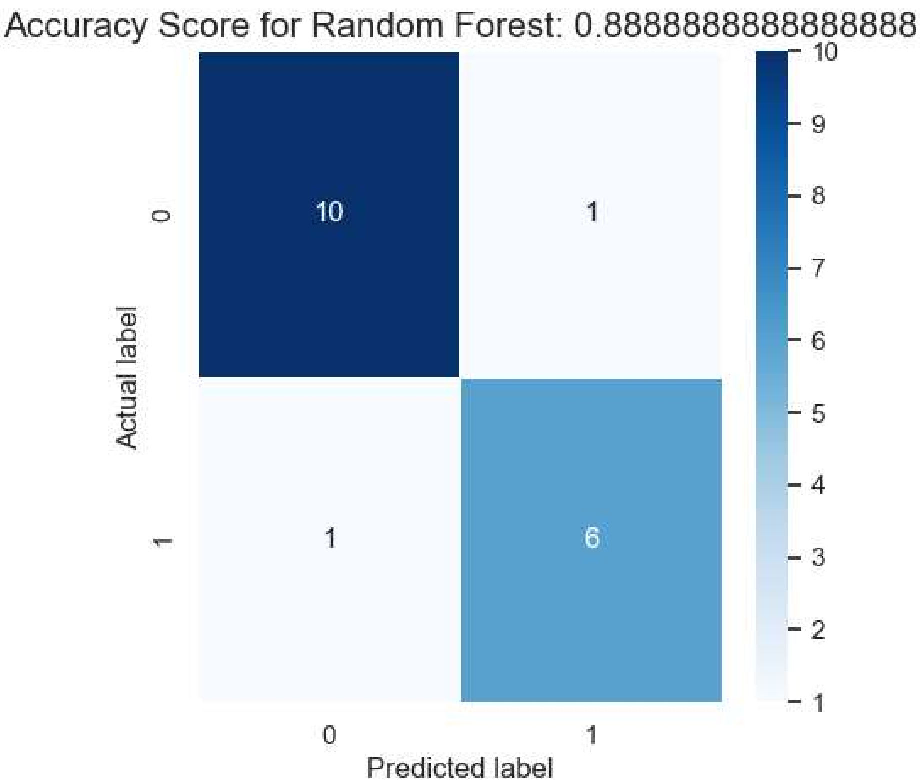


In [55]:
```
# compute SHAP values
import shap
explainer = shap.TreeExplainer(rfc)
shap_values = explainer.shap_values(X_test)
shap.summary_plot(shap_values[1], X_test.values, feature_names = X_test.columns)
```



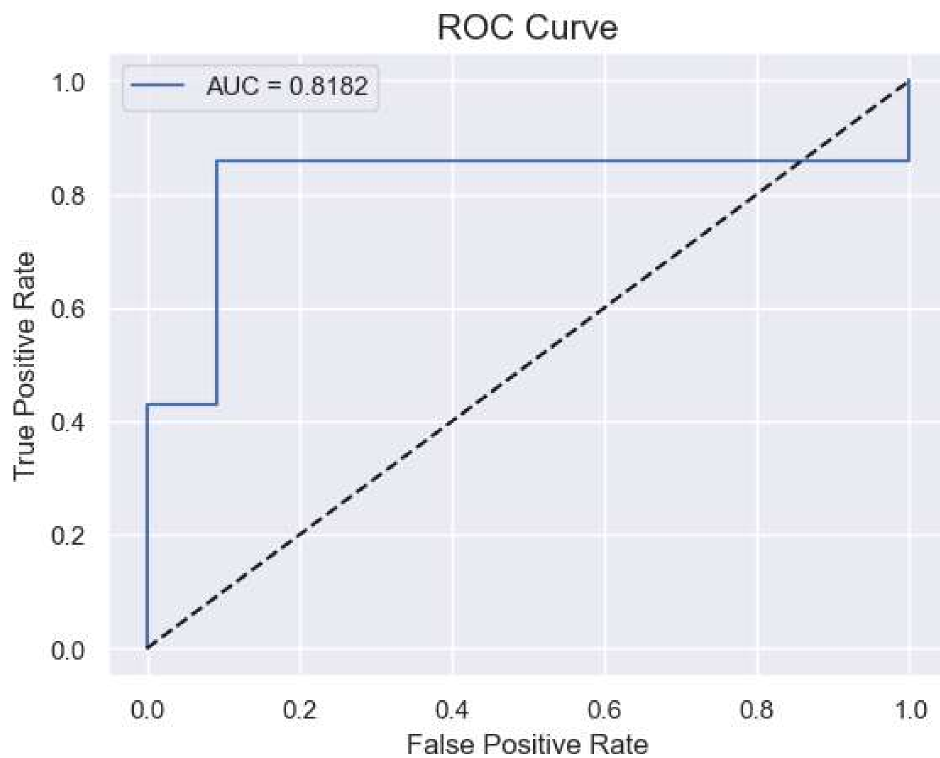
In [57]:
```
from sklearn.metrics import confusion_matrix
cm = confusion_matrix(y_test, y_pred)
plt.figure(figsize=(5,5))
sns.heatmap(data=cm,linewidths=.5, annot=True,  cmap = 'Blues')
plt.ylabel('Actual label')
plt.xlabel('Predicted label')
all_sample_title = 'Accuracy Score for Random Forest: {0}'.format(rfc.score(X_test, y_test))
plt.title(all_sample_title, size = 15)
```

Out[57]:
```
Text(0.5, 1.0, 'Accuracy Score for Random Forest: 0.8888888888888888')
```



In [58]:
```
from sklearn.metrics import roc_curve, roc_auc_score
y_pred_proba = rfc.predict_proba(X_test)[:][:,1]

df_actual_predicted = pd.concat([pd.DataFrame(np.array(y_test), columns=['y_actual']), pd.DataFram
df_actual_predicted.index = y_test.index

fpr, tpr, tr = roc_curve(df_actual_predicted['y_actual'], df_actual_predicted['y_pred_proba'])
auc = roc_auc_score(df_actual_predicted['y_actual'], df_actual_predicted['y_pred_proba'])

plt.plot(fpr, tpr, label='AUC = %0.4f' %auc)
plt.plot(fpr, fpr, linestyle = '--', color='k')
plt.xlabel('False Positive Rate')
plt.ylabel('True Positive Rate')
plt.title('ROC Curve', size = 15)
plt.legend()
```

Out[58]: <matplotlib.legend.Legend at 0x1aecca7cfd0>



Logistic Regression

In [61]:
```
from sklearn.linear_model import LogisticRegression
from sklearn.model_selection import GridSearchCV

# Create a Logistic Regression model
logreg = LogisticRegression(solver='liblinear', max_iter=10000)

# Define the parameter grid
param_grid = {
    'penalty': ['l1', 'l2'],
    'C': [0.01, 0.1, 1, 10]
}

# Perform a grid search with cross-validation to find the best hyperparameters
grid_search = GridSearchCV(logreg, param_grid, cv=5)
grid_search.fit(X_train, y_train)

# Print the best hyperparameters
print(grid_search.best_params_)
```

```
{'C': 0.1, 'penalty': 'l1'}
```

In [62]:
```
from sklearn.ensemble import RandomForestClassifier
logreg = LogisticRegression(solver='liblinear', max_iter=10000, C=0.1, penalty='l1')
logreg.fit(X_train, y_train)
```

Out[62]:
```
LogisticRegression(C=0.1, max_iter=10000, penalty='l1', solver='liblinear')
```

In [63]:
```
y_pred = logreg.predict(X_test)
print("Accuracy Score :", round(accuracy_score(y_test, y_pred)*100 ,2), "%")
```

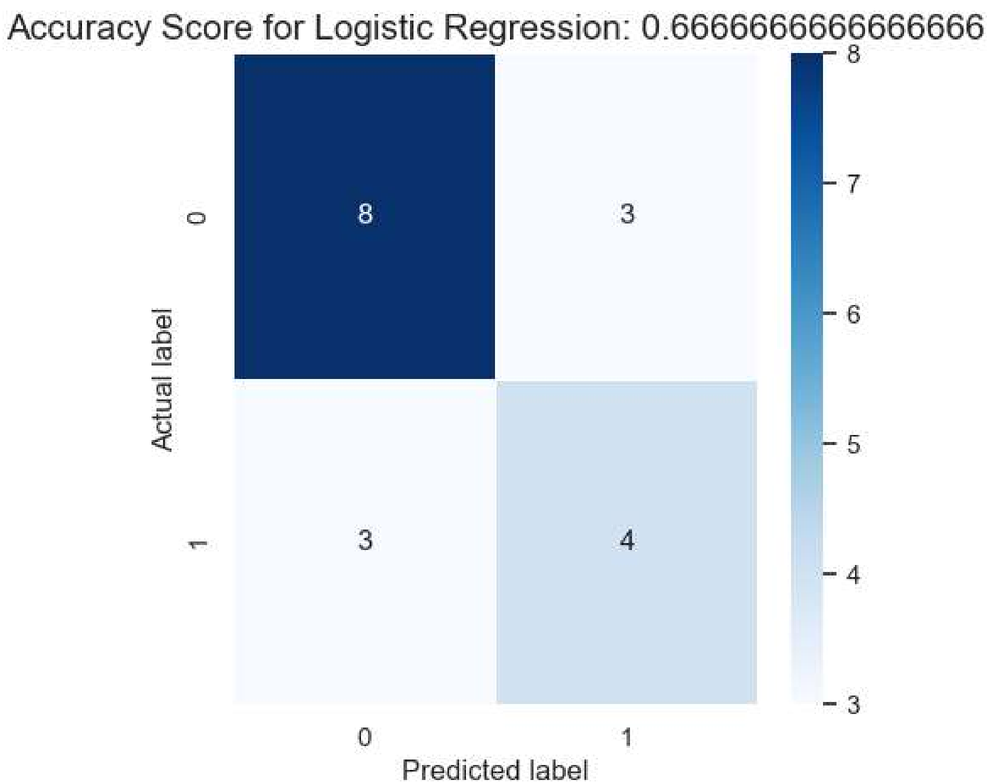
```
Accuracy Score : 66.67 %
```

In [65]:
```
from sklearn.metrics import accuracy_score, f1_score, precision_score, recall_score, jaccard_score
print('F-1 Score : ',(f1_score(y_test, y_pred, average='micro')))
print('Precision Score : ',(precision_score(y_test, y_pred, average='micro')))
print('Recall Score : ',(recall_score(y_test, y_pred, average='micro')))
print('Jaccard Score : ',(jaccard_score(y_test, y_pred, average='micro')))
print('Log Loss : ',(log_loss(y_test, y_pred)))
```

```
F-1 Score :  0.6666666666666666
Precision Score :  0.6666666666666666
Recall Score :  0.6666666666666666
Jaccard Score :  0.5
Log Loss :  11.513058731208593
```

In [67]:
```
from sklearn.metrics import confusion_matrix
cm = confusion_matrix(y_test, y_pred)
plt.figure(figsize=(5,5))
sns.heatmap(data=cm,linewidths=.5, annot=True,  cmap = 'Blues')
plt.ylabel('Actual label')
plt.xlabel('Predicted label')
all_sample_title = 'Accuracy Score for Logistic Regression: {0}'.format(logreg.score(X_test, y_tes
plt.title(all_sample_title, size = 15)
```

Out[67]:
```
Text(0.5, 1.0, 'Accuracy Score for Logistic Regression: 0.6666666666666666')
```



In [68]:
```
from sklearn.metrics import roc_curve, roc_auc_score
y_pred_proba = logreg.predict_proba(X_test)[:][:,1]

df_actual_predicted = pd.concat([pd.DataFrame(np.array(y_test), columns=['y_actual']), pd.DataFram
df_actual_predicted.index = y_test.index

fpr, tpr, tr = roc_curve(df_actual_predicted['y_actual'], df_actual_predicted['y_pred_proba'])
auc = roc_auc_score(df_actual_predicted['y_actual'], df_actual_predicted['y_pred_proba'])

plt.plot(fpr, tpr, label='AUC = %0.4f' %auc)
plt.plot(fpr, fpr, linestyle = '--', color='k')
plt.xlabel('False Positive Rate')
plt.ylabel('True Positive Rate')
plt.title('ROC Curve', size = 15)
plt.legend()
```

Out[68]: <matplotlib.legend.Legend at 0x1aecc934190>